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Proceedings
of

DIRECT SEEDING WORKSHOP

"One Man's Trash is Another Man's Treasure"

January 14, 1999
Dunvegan Motor Inn, Fairview, Alberta

Alberta
AGRICULTURE, FOOD AND
RURAL DEVELOPMENT

ALBERTA
REDUCED
TILLAGE
INITIATIVE

PFRA
Prairie Farm Rehabilitation Administration

Acknowledgements

Thanks to all the participants, speakers, helpers and the Dunvegan Motor Inn for their involvement in the Direct Seeding Workshop: "ONE MAN'S TRASH IS ANOTHER MAN'S TREASURE" held in Fairview on January 14, 1999. Approximately 120 people attended from across the Peace Region from as far away as Ft St. John, High Level and Valleyview.

Special thanks to the organizing committee, including Mark Przybylski and Vince Murray of Alberta Agriculture, and Blair English of PFRA for their assistance in locating sponsors, speakers, advertisers, as well as registration and room setup.

Thanks to the sponsors, including Alberta Reduced Tillage Initiative, Alberta Environmentally Sustainable Agriculture, Zeneca, Alberta Treasury Branch, BASF, Cyanamid, Farm Credit Corporation, United Farmers of Alberta, Ducks Unlimited, Fairview College and Houlder's.

Special thanks to Monsanto for sponsoring lunch and a jug of Roundup Transorb.

Thanks to Monsanto, Zeneca, Farm Credit Corporation, Agriculture Financial Services Corporation, Ducks Unlimited, Fish and Wildlife, Town of Fairview, and Alberta Agriculture, for supplying door prizes. Thanks to the Alberta Conservation Tillage Society for processing the income and expenses.

Special thanks to Linda Brazel for formatting and producing these proceedings.

We hope the day was beneficial for you and hope to see you next year around the same time for the Millennium edition of the Direct Seeding Workshop.

Randy Perkins
Acting Conservation Coordinator, Peace Region
Conservation and Development Branch
Alberta Agriculture, Food and Rural Development

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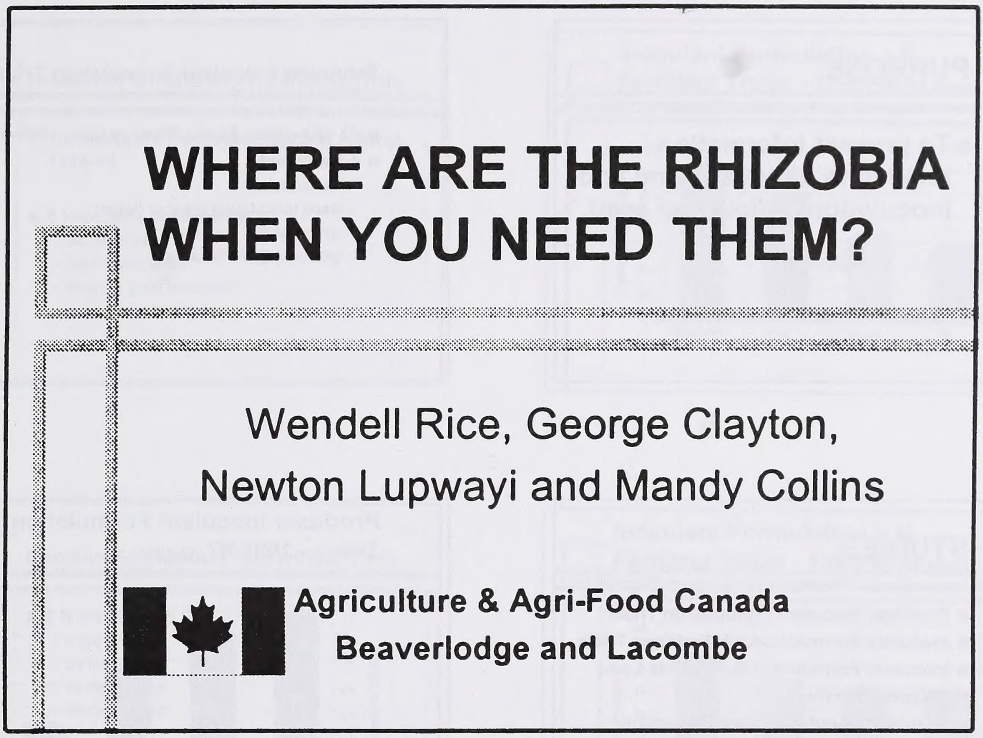
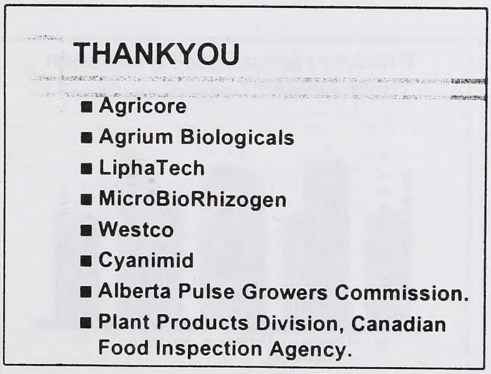


WHERE ARE THE RHIZOBIA WHEN YOU NEED THEM?

Wendell Rice, George Clayton,
Newton Lupwayi and Mandy Collins

Agriculture & Agri-Food Canada
Beaverlodge and Lacombe



THANKYOU

- Agricore
- Agrium Biologicals
- LiphaTech
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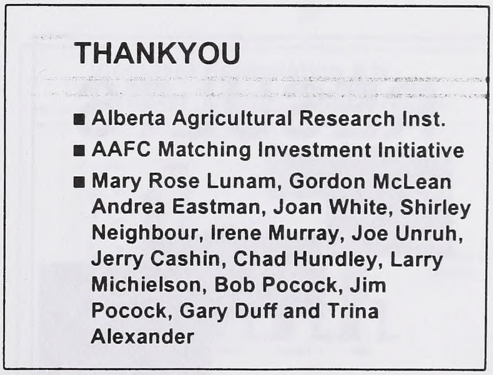
- Westco
- Cyanimid
- Alberta Pulse Growers Commission.
- Plant Products Division, Canadian Food Inspection Agency.



THANKYOU

- Alberta Agricultural Research Inst.
- AAFC Matching Investment Initiative
- Mary Rose Lunam, Gordon McLean Andrea Eastman, Joan White, Shirley Neighbour, Irene Murray, Joe Unruh, Jerry Cashin, Chad Hundley, Larry Michielson, Bob Pocock, Jim Pocock, Gary Duff and Trina Alexander

PURPOSE

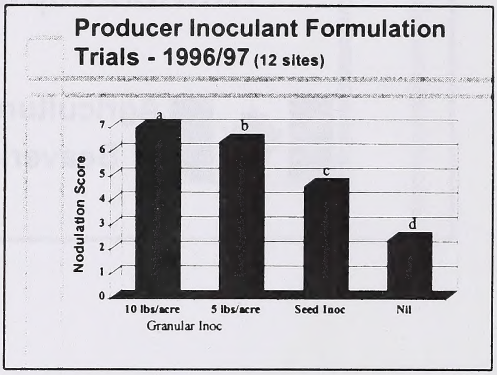
- To present information relative to direct seeding and inoculation of field pea seed.

Producer Inoculant Formulation Trials

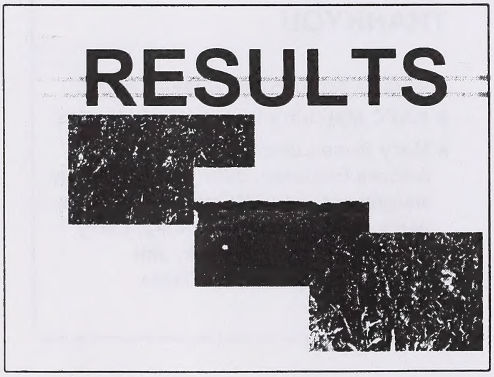
- 12 site-years Peace River region, 1996-97
- 4 treatments
  - no inoculant
  - seed inoculation (peat or liquid)
  - granular @ 5 lbs/acre
  - granular @ 10 lbs/acre

STUDIES

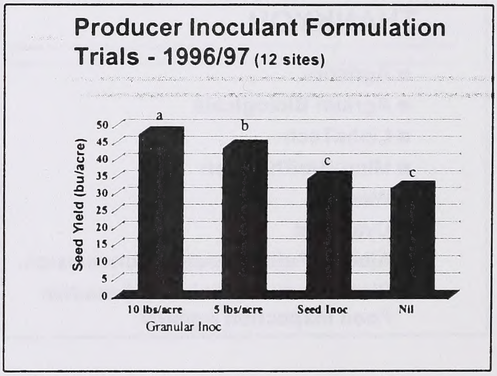
- Producer Inoculant Formulation Trials
- Inoculant Formulation x N Fertilizer Trials
- Inoculant Formulation & Rhizobia Load
- Rhizobia Survival
- Granular Inoculant Rate x Placement
- Granular Inoculant / Fertilizer Mixtures



Producer Inoculant Formulation Trials - 1996/97 (12 sites)



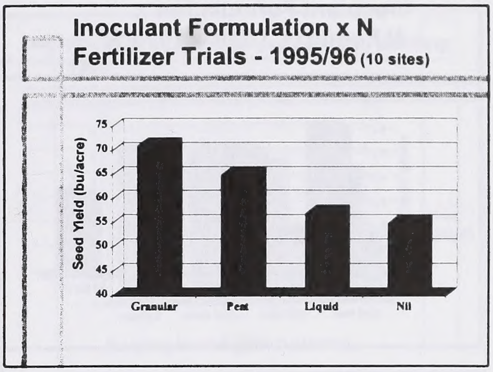
RESULTS



Producer Inoculant Formulation Trials - 1996/97 (12 sites)

Inoculant Formulation x N Fertilizer Trials

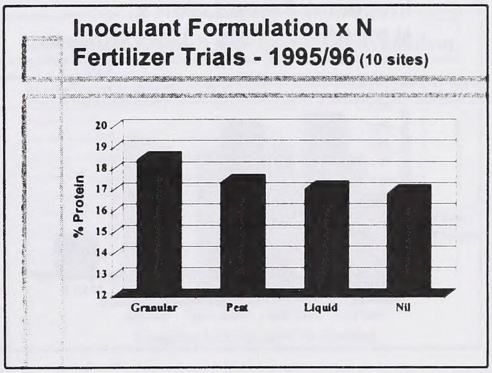
- 10 site-years Peace and Central Alberta, 1995-96
- 4 inoculant treatments
  - no inoculant
  - liquid inoculant
  - powder peat inoculant
  - granular inoculant



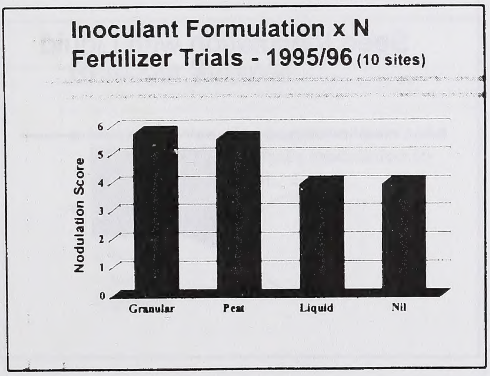
Inoculant Formulation x N Fertilizer Trials - 1995/96 (10 sites)

Inoculant Formulation x N Fertilizer Trials

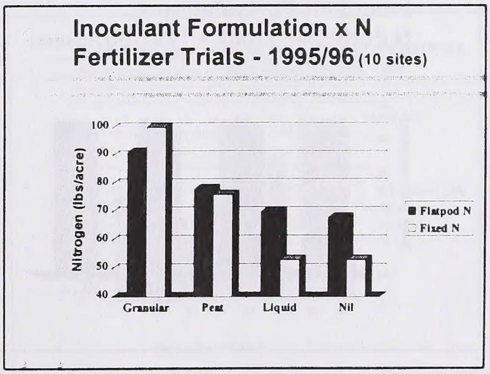
- 4 N treatments
  - 0 lbs N/acre
  - 20 lbs N/acre
  - 40 lbs N/acre
  - 80 lbs N/acre
- Data collected - nodulation, dry matter at flatpod, % N at flatpod, seed yield, seed protein, nitrogen fixation.



Inoculant Formulation x N Fertilizer Trials - 1995/96 (10 sites)



Inoculant Formulation x N Fertilizer Trials - 1995/96 (10 sites)



Inoculant Formulation x N Fertilizer Trials - 1995/96 (10 sites)

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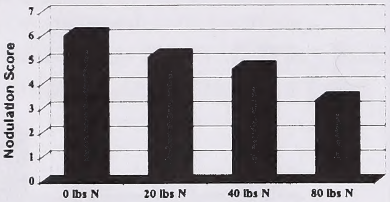
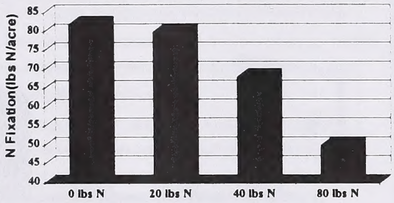


Inoculant Formulation & Rhizobia Load

- Numbers of viable rhizobia delivered by 24 peat, 8 liquid and 3 granular inoculants were calculated from official results of CLIPST Program (1997 & 1998).
- Spatial distribution of rhizobial populations when applied to the seed and soil was modeled

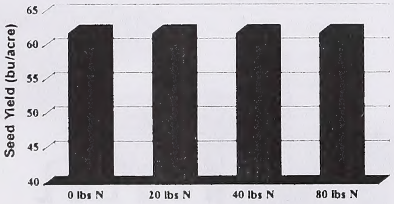
Inoculant Formulation x N Fertilizer Trials - 1995/96 (10 sites)



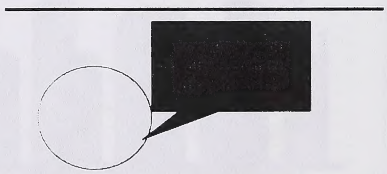
Number of rhizobia delivered by peat, liquid and granular field pea inoculants tested in 1997 and 1998.

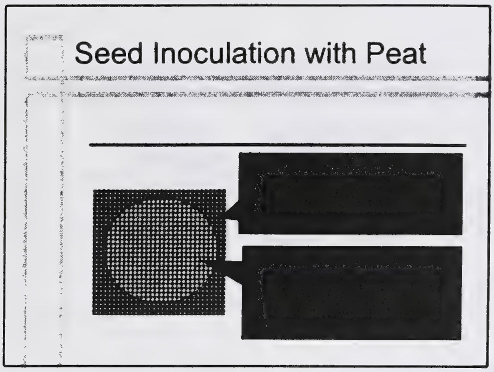
Inoculant formulation	Number of samples	Rhizobia per m^2	Rhizobia per seed
Peat	24	1.34×10^8	1.57×10^6
Liquid	8	1.62×10^8	1.90×10^6
Granular	3	2.08×10^8	2.44×10^6

Inoculant Formulation x N Fertilizer Trials - 1995/96 (10 sites)

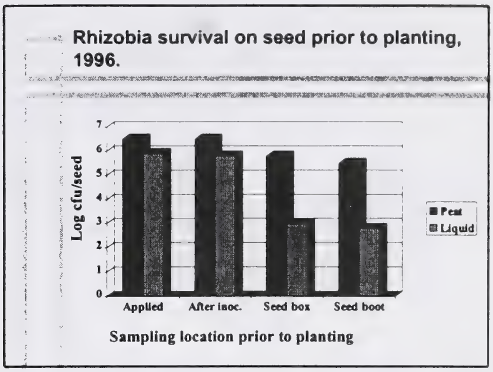


Seed Inoculation with Liquid

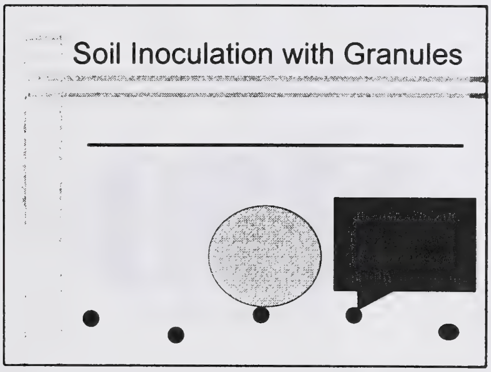




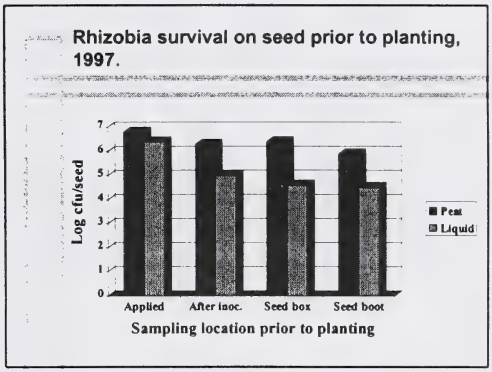
Seed Inoculation with Peat



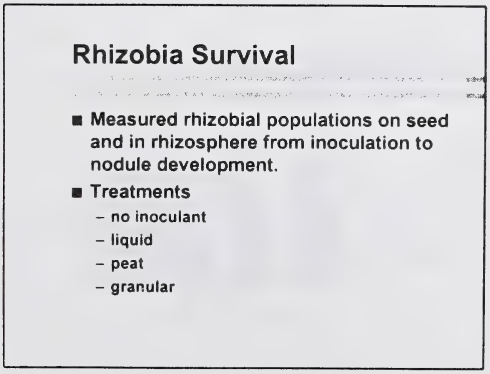
Rhizobia survival on seed prior to planting, 1996.



Soil Inoculation with Granules

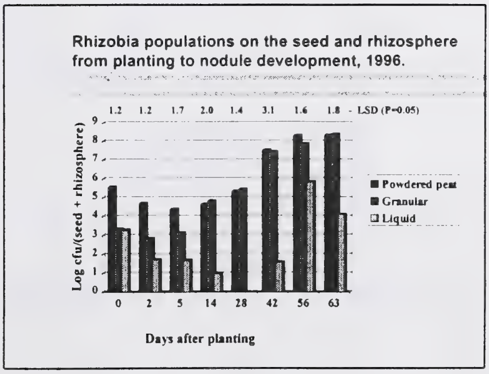


Rhizobia survival on seed prior to planting, 1997.

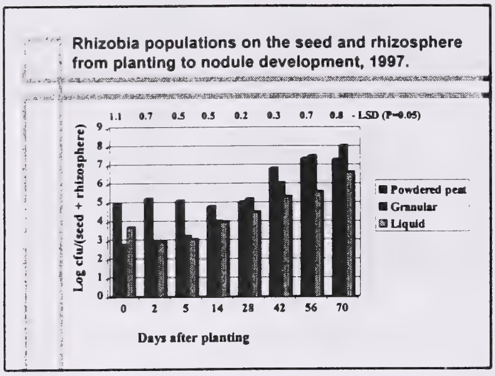


Rhizobia Survival

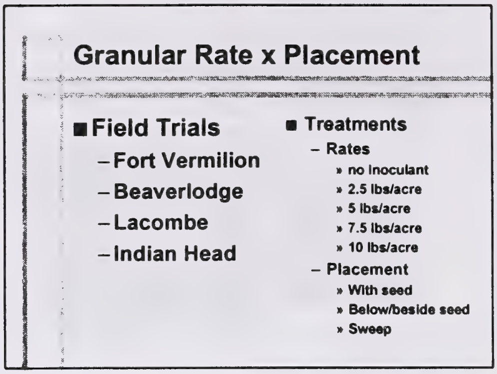
- Measured rhizobial populations on seed and in rhizosphere from inoculation to nodule development.
- Treatments
  - no inoculant
  - liquid
  - peat
  - granular



Rhizobia populations on the seed and rhizosphere from planting to nodule development, 1996.

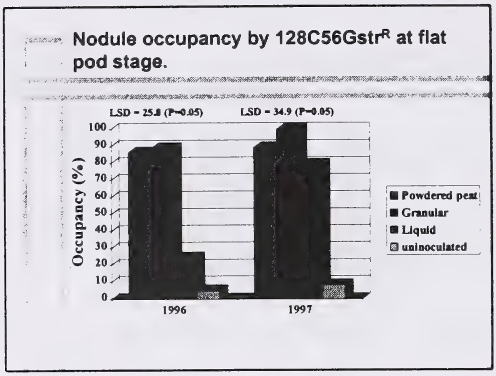


Rhizobia populations on the seed and rhizosphere from planting to nodule development, 1997.

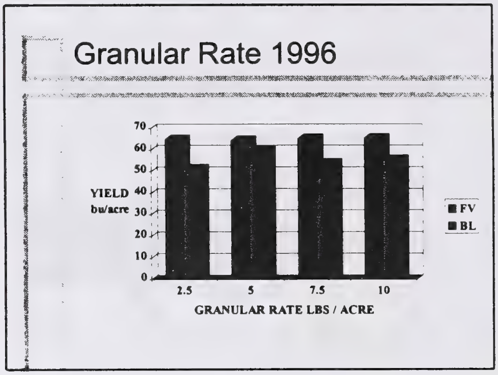


Granular Rate x Placement

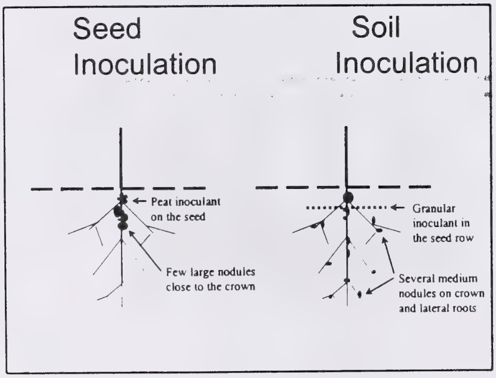
- **Field Trials**
  - Fort Vermilion
  - Beaverlodge
  - Lacombe
  - Indian Head
- **Treatments**
  - Rates
    - no inoculant
    - 2.5 lbs/acre
    - 5 lbs/acre
    - 7.5 lbs/acre
    - 10 lbs/acre
  - Placement
    - With seed
    - Below/beside seed
    - Sweep



Nodule occupancy by 128C56Gstr^R at flat pod stage.

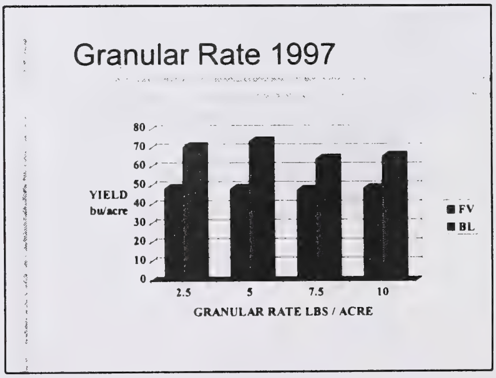


Granular Rate 1996

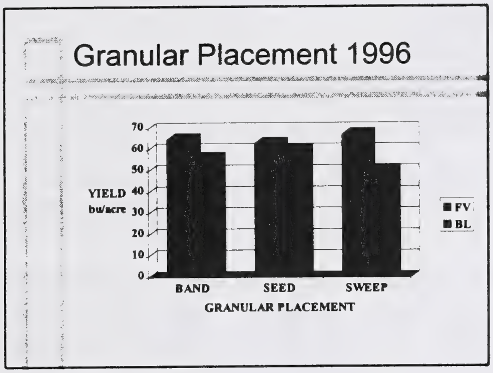


Seed Inoculation / Soil Inoculation

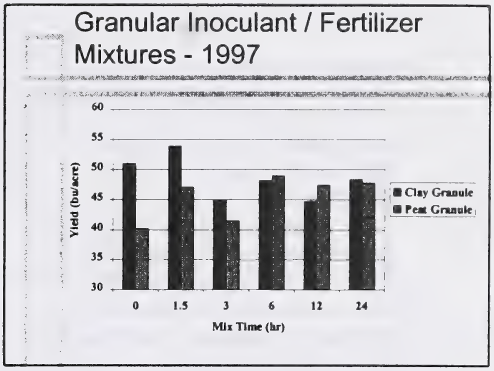
Seed Inoculation
Soil Inoculation
Peat inoculant on the seed
Few large nodules close to the crown
Granular inoculant in the seed row
Several medium nodules on crown and lateral roots



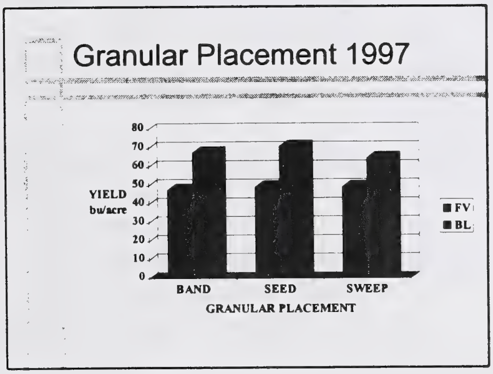
Granular Rate 1997



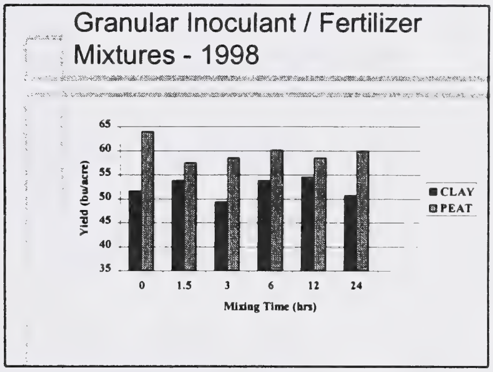
Granular Placement 1996



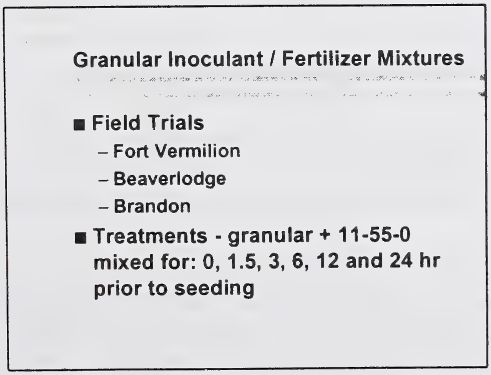
Granular Inoculant / Fertilizer Mixtures - 1997



Granular Placement 1997

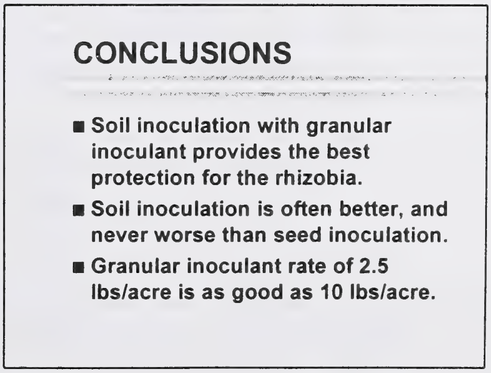


Granular Inoculant / Fertilizer Mixtures - 1998



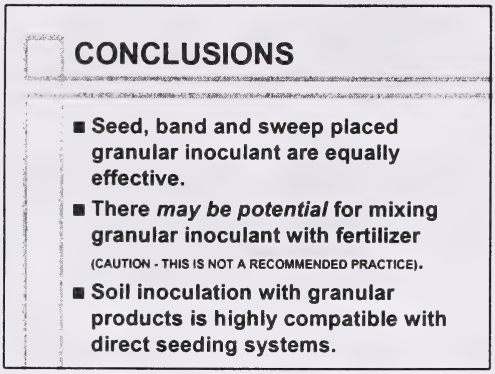
Granular Inoculant / Fertilizer Mixtures

- Field Trials
  - Fort Vermilion
  - Beaverlodge
  - Brandon
- Treatments - granular + 11-55-0 mixed for: 0, 1.5, 3, 6, 12 and 24 hr prior to seeding



CONCLUSIONS

- Soil inoculation with granular inoculant provides the best protection for the rhizobia.
- Soil inoculation is often better, and never worse than seed inoculation.
- Granular inoculant rate of 2.5 lbs/acre is as good as 10 lbs/acre.



CONCLUSIONS

- Seed, band and sweep placed granular inoculant are equally effective.
- There *may be potential* for mixing granular inoculant with fertilizer (CAUTION - THIS IS NOT A RECOMMENDED PRACTICE).
- Soil inoculation with granular products is highly compatible with direct seeding systems.

Creeping Red Fescue Removal Without Tillage

Garry Ropchan
Research Coordinator
Central Peace Conservation Society (CPCS)
Spirit River, Alberta

INTRODUCTION

The adoption of zero tillage depends on producers continuing with a crop rotation as close to their previous seeding program as possible. If the adoption of zero till requires that a producer can no longer grow a (profitable) crop used in their rotation then they become less likely to adopt zero till. One particular crop grown within the central Peace region that may pose problems for full integration within a zero till system is creeping red fescue (CRF).

Creeping red fescue has played an important role in crop rotations in this region as it maintained high net profit status when annual crops (cereals and oilseeds) were depressed in price. Although a perennial plant, CRF crops are only kept for a four year period then is removed from the rotation, typically by tillage.

Although several different techniques are used with varying levels of success the traditional means of fescue removal consists of:

1) plowing the field
2) repeated discing to break up sod
3) cultivation and harrowing.

Requires a year of summerfallow .

Some disadvantages associated with summerfallow is the soil is damaged from erosion and the soil/aggregate structure can be severely damaged, so is there some other technique? This desire for developing new techniques is hampered by the fact that CRF production is only undertaken in large acreages in western Canada within the Peace River region, thus bodies that are normally responsible for agricultural research (Agriculture Canada and Universities) do not have the resources to allocate towards addressing CRF production and its associated problems.

We have the opportunity for dealing with problems that are of a local concern. For organizations like the Central Peace Conservation Society this means that for the first time funds were available to address issues that were relevant to only this region.

Dr. Martin Entz has indicated that those producers producing CRF seed in the province of Manitoba who converted to zero tillage seeding dropped CRF from their rotations. The benefits accrued from zero tillage seeding for the rest of the crops in their rotation far outweighed the benefits from selling creeping red fescue (personal communication), but they may not be acceptable for everyone.

Creeping red fescue will be seen by zero till producers as a weed. As pure zero till systems do not incorporate mechanical tillage for weed control (direct seeding may include a fall tillage pass for fertilizer application, but usually with narrow openers, thus would not have a weed control benefit) they require the use of "burnoff" herbicides for weed control prior to seeding the crop. The current burnoff herbicide consists of glyphosate (most commonly under the trade name Roundup) applied at 0.5 l/ac rate. This rate is not effective in controlling volunteer patches of fescue that occur in land that is seeded to annual crops after the year of summerfallow/tillage. The issue of using a herbicide to kill fescue has lead to a number of basic questions:

1) What rates of glyphosate are effective?
2) Does the time of application effect performance?
3) The effect of water volume.
4) The effect of surfactants.
5) Are there herbicides other than glyphosate that could be used?
6) What stage of fescue growth after summer harvest would be required before a herbicide application is effective?

The problems with systemic herbicides (ie. glyphosate) is it is difficult to get herbicide into the root system. Creeping red fescue is especially problematic from the herbicide absorption aspect. It has a very low level of leaf surface area (thus the question dealing with how much regrowth after harvest is required before there is enough leaf surface area to absorb enough herbicide to kill the plant). The leaf is orientated towards the vertical plane. This means that any herbicide droplets striking the surface of the leaf may not adhere to the leaf surface and may simply roll off. The waxy cuticle of the surface of the leaf adds to this problem. This leads to questions dealing with rolling prior to spraying to give a more horizontal leaf surface, the use of crowfoot or coil packers to damage the cuticle of the leaf prior to herbicide application. Paul Jungnitsch of FARA has studied the benefit of pre-spraying packing but did not find it beneficial.

OBJECTIVES

CPCS conducted a trial hoping to generate information looking at components of CRF removal in zero tillage systems. The project was to compare Roundup at 2 liters per acre with a tillage program for eliminating the fescue. This project received product support from Monsanto Canada Inc. and CPCS wishes to recognize their contribution.

METHODS

The trial was located about 10 miles west of Codesa and the cooperator was Robert and Arlene Barlund. The same site was used for the four year project and the treatments were kept of the same strips each year. The plot was always seeded using a Haybuster 8000 zero till hoe drill.

The **1998** trial was located at the following site:

Codesa - SE 01 78 02 W6
Cooperator - Robert Barlund

The tillage system consisted of a plowing followed by a discing and two harrowings. There were three repeats of each treatment in a randomized block design. The previous crop was fescue. The treatments were:

1) plowed up fescue
2) 2 l/ac of Roundup sprayed

May 11 a herbicide application consisting of 2 liters of Roundup and 0.67 liter of ammonium sulfate was applied with 5 gallons of water per acre. 110' ER nozzles were used. There was very little fescue present at this time. The only fescue that could be found growing was in the spray misses from the 1997 burnoff application. Starting on May 20 the plot was seeded using a Haybuster 8000 zero till hoe drill with a 10-inch row spacing and paired row seeding (3 inches between rows). Seeding was completed on May 21. Kasota barley was seeded at a rate of 105 lb/ac about 1 inch deep.

The fertility program consisted of 65 lb N, 23 lb P_20_5, 15 lb K_2O and 0 lb S /ac and all of the fertilizer was deep banded 2 inches below and in the middle of the paired seed row.

Incrop weed control consisted of an incrop herbicide application of Ally (donated by Dupont). The sprayed strips were very clean, however, the tilled strips contained a very heavy population of biennial wormwood.

On September 3 the plot was combined and weighed. The results for all four years of the trial are given in Table 1. The economic comparison was performed using costs obtained from the Alberta Agriculture, Food and Rural Development's Farm Operations Cost Guide (Agdex 825-1). The costs for the various operations are given in Table 2.

Table 1: Results of Non Tillage Removal of Fescue, 1995-1998, Barlund Site

Year	Treatment	Crop	Yield bu/ac	$/acre
1995	Plowed Sod	oats	124.7	219.65
	Sprayed Sod	oats	79.8	126.10
1996	Plowed Sod	oats	78.0	138.25
	Sprayed Sod	oats	81.0	137.80
1997	Plowed Sod	oats	104.3	184.60
	Sprayed Sod	oats	87.3	135.17
1998	Plowed Sod	barley	19.5	7.00
	Sprayed Sod	barley	35.2	16.87

Table 2: Economic Costs

Operation	Cost/Acre
discing	$ 6.25
harrowing	$ 1.75
spraying	$ 3.50
seeding, conventional	$ 8.00
seeding, zero till	$16.63
Roundup	$17.90
Ammonium Sulfate	$ 1.40
Oats valued at	$ 2.00/bu
Barley valued at	$ 2.50/bu

The **1997** trial was located at the following site:

Codesa - SE 01 78 02 W6
Cooperator - Robert Barlund

In 1997 the tillage system consisted of a plowing followed by a discing and two harrowings. There were three repeats of each treatment in a randomized block design. The previous crop was oats. The treatments were:

1) plowed up fescue
2) 2 l/ac of Roundup sprayed

On June 2 a herbicide application consisting of 2 liters of Roundup and 1.0 liters of ammonium sulfate was applied with 5 gallons of water per acre. 110' ER nozzles were used. The ground at this time was covered by fescue that was 15 to 20 cm tall. The tilled strips were disced on June 6.

- The plot was seeded on June 8 using a Haybuster 8000 zero till hoe drill with a 10" row spacing and paired row seeding (3 inches between rows). Derby oats were seeded at a rate of 110 lb/ac about 1 inch deep.

- The plot was seeded on June 8 using a Haybuster 8000 zero till hoe drill with a 10" row spacing and paired row seeding (3 inches between rows). Derby oats were seeded at a rate of 110 lb/ac about 1 inch deep.

- The fertility program used provided a total of 70 lb N, 25 lb P_20_5, 10 lb K_2O and 0 lb S /ac. No problems were encountered in the seeding operation.

- Observations made on June 12 found very good levels of fescue control compared to missed strips. Even as late as August 25 there were only signs of fescue regrowth in the heavier sod areas and the fescue was only at the one or two leaf stage. It was very difficult to discern where the boarders between treatments were.

- On September 23 the center of each plot was swathed. Narrow-leafed hawksbeard and stinkweed were the prevalent weeds present. Fescue regrowth in both the tilled and sprayed strips could be seen after the swathing operation.

- The plot was combined on October 19 and weighed using a weight wagon. Samples were retained to determine the % moisture, % dockage and bushel weight.

The **1996** trial were located at the following site:

Codesa - SE 01 78 02 W6
Cooperator - Robert Barlund

This was the second year of the study. This site was located 9 miles east of Wanham on a loam to clay loam Dark Gray soil (Esher/Donnelly complex). The objective of this site was to compare the economics between trying to remove the fescue crop by herbicide and removal through tillage.

There were three repeats of each treatment in a randomized block design. The previous crop was fescue. The treatments were:

1) plowed up fescue sod
2) 2 l/ac of Roundup sprayed

On May 23 a herbicide application consisting of 2 liters of Roundup and 2 liters of ammonium sulfate was applied with 5 gallons of water per acre. 110' ER nozzles were used. The ground at this time was covered by fescue that was 15 cm tall. The same fescue strips that were sprayed in 1995 were sprayed in 1996.

In the second year of the study the tillage system consisted of two discings and two harrowings. These tillage operations were performed on May 27. Starting on May 28 the plot was seeded using a Haybuster 8000 zero till hoe drill with a 10" row spacing and paired row seeding (3 inches between rows). Seeding was completed on May 29. Derby oats were seeded at a rate of 115 lb/ac about 1 inch deep. The seed was treated with 1/2 recommended rate Vitavax single seed treatment. The soil test revealed the following information:

Nitrogen:	18 lb/ac, deficient	Potassium:	411 lb/ac, optimum
Phosphorus:	19 lb/ac, deficient	Sulfur:	36 lb/ac, optimum

The soil pH was 6.5 in the 0-6" layer and contained 4.3% organic matter. The target yield of 120 bu/ac oats called for 91 lb N, 43 lb $P_2 0_5$, 0 lb K_2O and 0 lb S /ac.

The fertility program used consisted of 53 lb of N in the form of anhydrous ammonia deep banded 1.5 inches below the seed and in the middle of the paired seed row. 5.5 lb of N, 25 lb of P and 13.5 lb of K were applied with the seed for a total of 58.5 lb N, 25 lb $P_2 0_5$, 13.5 lb K_2O and 0 lb S /ac.

On June 6 the cooperator informed that there were some severe crusting problems on the tilled sod strips and that they were harrowed to break up the crust and improve germination. The sprayed sod strips did not crust and thus no harrowing operation was required. There were fewer sprayer misses this year but where we did miss the fescue growth was very vigorous and did heavily compete with the oat crop.

The cooperator applied an incrop herbicide program consisting of 120 ml/ac of Banvel and 400 ml/ac of MCPA on June 10 to control the main weed problem - Canada thistle.

Unlike 1995, there were no observable differences between the oats seeded into the tilled ground and the oats seeded into the sprayed sod. Swathing started on September 20. The center strip was cut out and the remainder of the plot swathed after. Both treatments continued to have fescue present. Due to inclement weather we were unable to harvest the plot. 0.5 m portions of swaths were collected and threshed.

The **1995** trial was located at the following site:

Codesa - SE 01 78 02 W6
Cooperator - Robert Barlund

The tillage system consisted of a plowing followed by a discing and two harrowings. There were three repeats of each treatment in a randomized block design. The previous crop was fescue. The treatments were:

1) plowed up fescue
2) 2 l/ac of Roundup sprayed

On May 16 a herbicide application consisting of 2 liters of Roundup and 1.5 liters of ammonium sulfate was applied with 5 gallons of water per acre. 110' ER nozzles were used. The ground at this time was covered by fescue. The fescue was 10 to 15 cm tall. There was clover and curled dock growing at this time. Half of the plot (three strips) was plowed, disced and harrowed twice.

Starting on May 20 the plot was seeded using a Haybuster 8000 zero till hoe drill with a 10" row spacing and paired row seeding (3 inches between rows). Seeding was completed on May 21. Derby oats were seeded at a rate of 125 lb/ac about 1.5 inches deep.

The fertility program used consisted of 57 lb of N in the form of anhydrous ammonia deep banded 1.5 inches below the seed and in the middle of the paired seed row. 6 lb of N, 26 lb of P and 15 lb of K were applied with the seed for a total of 63 lb N, 26 lb P_20_5, 15 lb K_2O and 0 lb S/ac.

On September 25 the plot was combined and weighed.

DISCUSSION

The magnitude of difference in the revenue per acre between the treatments after three years does not yet indicate that creeping red fescue can be removed from rotation without the use of tillage equipment without economic penalty. While the oat yield on the sprayed strips maybe adequate, it in no way compares favorably to the oat yield on the plowed sod strips.

CONCLUSIONS

The magnitude of difference in the revenue per acre between the treatments after four years does not yet indicate that creeping red fescue can be removed from rotation without the use of tillage equipment without economic penalty. While the oat yield on the sprayed strips maybe adequate, it in no way compares favorably to the oat yield on the plowed sod strips.

After four years of trials removing the fescue without tillage is proving to be a difficult objective. The level of fescue growth on both tilled and sprayed ground is not yet to the point of either system being sufficient to call the fescue "removed" from rotation. The economics are still heavily in favor of the tillage treatment (contribution margin of $137.38, average of four years) compared to the spraying treatment (contribution margin of $103.99, average of four years).

This site will be monitored in 1999 to see if there is fescue regrowth. It does appear that the removal of fescue without tillage will not be a one year operation, but that a system approach over several consecutive years will be required. Further work is required in the areas of the effect of seeding and fertilizer rates in sod seeding.

A new trial was started in the summer of 1998 to look at different, intensive one year herbicide applications without the option of growing a crop. This includes different spring, summer and fall spray dates, different water volumes and Classic vs. Transorb Roundup.

STAY TUNED FOR FURTHER UPDATES!

Timing of Weed Removal Study

Garry Ropchan
Research Coordinator
Central Peace Conservation Society (CPCS)
Spirit River, Alberta

The initial work was conducted by Dr. Neil Harker, Agriculture Canada, LaCombe, Alberta. To speed up information gathering and dissemination it was decided to gather more data through a cooperative project between Dr. Harker and several of the Applied Research Associations in the province. The associations were GRO from Westlock, BRARA from Camrose, PRSCA from the B.C. Peace, SARDA from Falher, NPARA from Manning and Fort Vermilion and CPCS from Spirit River.

Dr. Harker's results have been sent to me and will be presented later on. As well, I have the results from the trials that I conducted at Silver Valley and Rycroft (CPCS) and the preliminary results from the other ARA's.

Methodology of Project

RR canola and wheat was used and the same herbicide was used for both crops (0.5 l/ac Roundup, and Horizon and Prestige). Fields would be monitored after seeding as the crop was emerging. When 20 plants/ft^2 had emerged, this was to be called the day of emergence. At 7, 14 and 21 Days After Emergence (DAE) the crop would be sprayed. this would be roughly at the 1, 3 and 5 leaf stage. Ten 1/4 m^2 samples from each strip (two replicates) were obtained on each of the three spray dates. The weeds present and the crop and weed leaf stages were recorded and the samples dried and weighed.

Simply put, a lot of time went into this project. Visual ratings for weed control were made against a check strip that was located in the middle of each plot. Yield, dockage, grade and moisture data were collected at harvest time. The collective results will be analyzed to develop guidelines for when herbicides should be applied.

Timing of Weed Removal (TWR)

Producers generally wait to spray weeds - WHY?

They want to kill every weed they possibly can. If a herbicide can be used up until the flag leaf of a crop and the 6th leaf of a weed, then producers will wait that long in order to get the most recently germinated weeds. After all who wants to spray more than once in a crop?

But what about the effect of those weeds that have been growing right along side our crop? Well we have planted our cereal crop, it has germinated and so have the weeds. So we wait. Well what is happening? The weeds are using up moisture, using up nutrients, competing for sunlight (shading). This is going to reduce our yield -- no argument right? But what else is involved?

Question - At what point in a plant's life does it determine what its yield potential is going to be?

Yield on a plant is set by the # heads it produces, the # of seeds on each head and the weight of each seed. Pretty straight forward. Plants will determine this by looking at soil moisture, the nutrient supply, sunlight and the degree of weed competition around them and will then decide how much seed they will be able to produce this year. If you cut open a plant and examine it under the microscope, you can see the development of the heads and the number of seeds that will be produced on each one. In the case of cereals, the plant determines this information at Zadok's growth stage 30 to 32.

So when is this? Boot stage? Heading?

This is about the 4th leaf stage! So at the 4th leaf stage the plant has determined what its maximum yield potential is going to be. This will not increase by a great degree even if excellent growing conditions occur later in the season. Why?

The 4th leaf stage comes along, the plant finds out that there is a lack of moisture, a lack of nutrients and a lot of weeds here. It tells itself, well, no use in aiming for a high yield, conditions are not favorable. Cereal heads and seeds take a long time to form and develop, around 90 days or so, and that is why the potential yield is determined so very early on. If you have poor early conditions at the 4th leaf stage, the number of seeds the plant thinks it can produce will be set and it can't change it later on.

Day 0 - crop planted
Day 20 - yield potential established
Day 110 - crop harvested

If conditions improve later on, it is too late. It takes about 80 to 90 days from when the seeds and head start to form to when the crop is mature to harvest. If we remove the weeds and add more fertilizer at the 6th leaf stage or later, say on Day 30, it is too late. The crop won't mature in time so it doesn't bother to produce more new heads or to add more kernels to each head -- there simply isn't time.

So what about the dreaded second (later) flushes of weeds, the reason we delay spraying? Having the crop's yield established under weed free conditions is critical -- to produce as many heads with as many kernels per head as possible -- to give us highest potential yield. If poor conditions do occur later on, some seed will be aborted, but remember, if good conditions do occur, **more can not** be added.

This may be one reason why split fertilizer applications are inconsistent in increasing yields. Protein for existing kernels can be increased, but additional kernels can not be added! Having the crop's yield set under weedy conditions results in fewer heads with fewer kernels being produced. Even if conditions improve later on, more heads and seeds **can not** be produced.

Weeds removed crop 6 LS yield potential	Weeds removed crop 4 LS yield potential
3 heads each with 35 kernels	4 heads each with 40 kernels

Which is in a better position to take advantage of favorable conditions? The weedy field crop will run out of potential long before the clean field.

Now what about canola? Canola is a bit different from cereals in that it can quickly produce more seeds and pods to adopt with conditions - TO AN EXTENT. Canola yield is still set early on in the plant's life. The critical factor in canola yield is Leaf Area Index, or LAI. LAI refers to the surface area of a plant that is able to photosynthesize, so the nice green leaf, pod and stem area. One square meter LAI per one square meter of ground will produce about 10 bushels per acre. So that magic 50 bu/ac crop we'd all like to have needs a LAI of 5.

Stress early in a canola plant's life from lack of moisture, nutrients or competition from weeds reduces LAI and yield. This maybe why, for example, we see such performance from the InVigor line of canola seed. InVigor's are known for filling out rapidly, they have lots of vegetative growth, lots of photosynthetic surface area, a high LAI and consequently……. HIGHER YIELDS! Of course for $5 or $6 per pound of seed, what else would we expect. So we know that having weeds use up moisture, sunlight and nutrients will reduce our crop yield. Since plants set crop yield based on growing conditions very early on, eliminating weeds is important.

There is one more factor as well that may be a spoiler in getting higher yields from earlier weed control. Some plants have the ability to produce compounds that will negatively affect other plants around them. For example, evergreen tree needles acidify the soil so other plants can't grow. Quackgrass also has this ability. Decomposing plant residues will release compounds that will negatively effect other plants. Canola, flax and sunflowers contain phototoxins (compounds such as tannins) which are retardants of plant growth. Certain weeds also have this characteristic (stinkweed). So the larger the weeds are when killed, the greater the phototoxin content, which is concentrated in the leaf tissue rather than in the straw and stems. So the larger the weeds get, the more toxins they will be adding to the soil when we kill them and the greater the stress placed on the crop we have planted.

To review, weeds rob moisture, nutrients and sunlight. Yield determination is generally set very early in a crop's life based on the current conditions. Decomposing weeds release toxins that can harm plants.

DR. HARKER'S COMMENTS

Note that effects of TWR were much less dramatic in 98 than in 97. In 98, the El Nino produced dryer conditions that led to poor early weed emergence. Therefore, at the early application timing there were few weeds that had emerged. Producers would probably not apply herbicides with only a few emerged weeds, **but notice** that the yields still did not generally increase with later applications.

The 98 data indicates the importance of controlling early emerging weeds (even if there are only a few) versus late flushes that everyone seems to worry so much about.

TWR Handweeding in Peas Methods
'Carrera' peas planted and cross-seeded with Tartary buckwheat or wild oat (Lacombe and Lethbridge)
Weeds were removed at weekly intervals after pea emergence
Weed weights and pea yields were determined
TWR x Weed Species interaction not significant, therefore all results are averaged across both weed species *(the benefits of early weed removal are independent of weed species!).* ***No herbicide applications were made.***

Graphs 1 to 7

TWR in 3 Crops with Herbicides Methods
Barley, Canola and Peas cross-seeded with cultivated Oat
Weeds removed at 7, 14 and 21 DAE as follows:
Barley 'Falcon': Achieve
Canola 'Quest': Roundup
Peas 'Swing': Odyssey
Crop and Weed growth stages, weed weights, and yield determined

Graphs 8 to 13

TWR in Roundup Ready Canola
Methods
Several central and northern Alberta Sites
Roundup Ready Canola (Quest) planted and cross-seeded with cultivated oat at 2 locations
ZT vs. CT regimes (ZT ± Burn-off)
Weeds were removed at 7, 14, 21 DAE
Data: weed weights and canola yields

Graphs 14 to 15

CPCS conducted two of these trials in the central Peace region. Both RR canola (site located at Silver Valley) and Extra Strong Wheat (site located at Rycroft) were used. The recommended rate of Horizon and Prestige was applied in the wheat on each of the three spray dates. A single 0.5 l/ac application was made in the RR canola on each of the three spray dates.

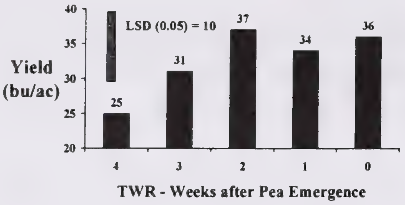
Graphs 16 to 17

The initial results from all of the ARA sites in the region are given in the following two graphs. The overall average is given on the very right hand side.

Graphs 18 to 19

Graph 1

1996 - Lethbridge

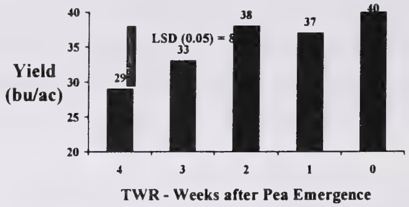


TWR - DAE	28	21	14	7
Pea Leaf Pairs	6	4	2	1

Weedy plot yields averaged 22 bu/ac so waiting 28 DAE to spray gave little yield benefit

Graph 2

1997 - Lethbridge

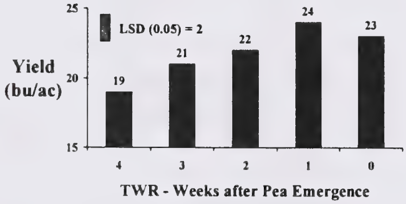


TWR - DAE	28	21	14	7
Pea Leaf Pairs	6	4	2	1

Weedy plot yields averaged 14 bu/ac

Graph 3

1998 - Lethbridge

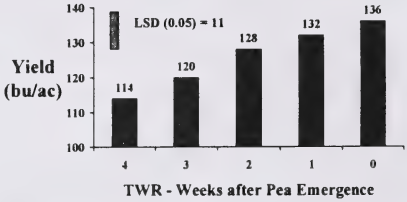


TWR - DAE	28	21	14	7
Pea Leaf Pairs	6	4	2	1

Weedy plot yields averaged 6 bu/ac

Graph 4

1996 - Lacombe

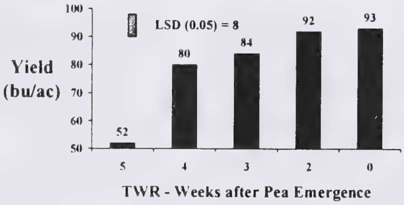


TWR - DAE	28	21	14	7
Pea Leaf Pairs	6	4	2	1

Weedy plot yields averaged 27 bu/ac

Graph 5

1997 - Lacombe

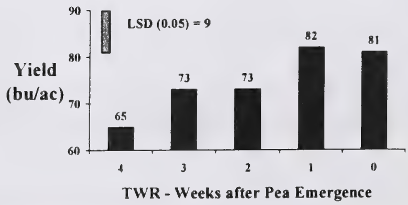


TWR - DAE	35	28	21	14
Pea Leaf Pairs	7	5	3	2

Weedy plot yields averaged 36 bu/ac

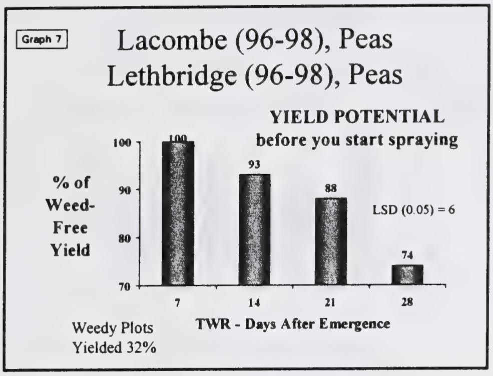
Graph 6

1998 - Lacombe

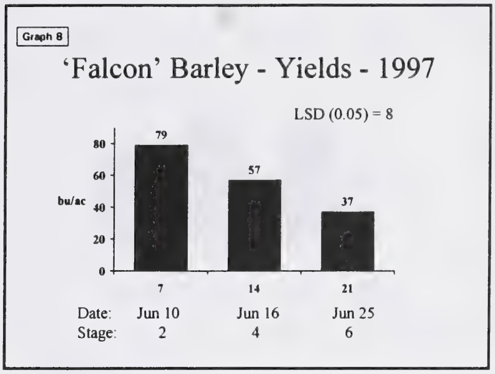


TWR - DAE	28	21	14	7
Pea Leaf Pairs	6	4	2	1

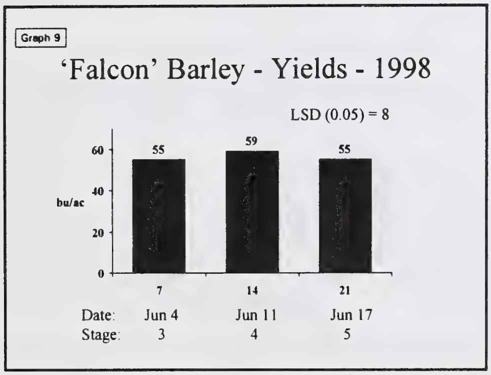
Weedy plot yields averaged 22 bu/ac


Graph 7

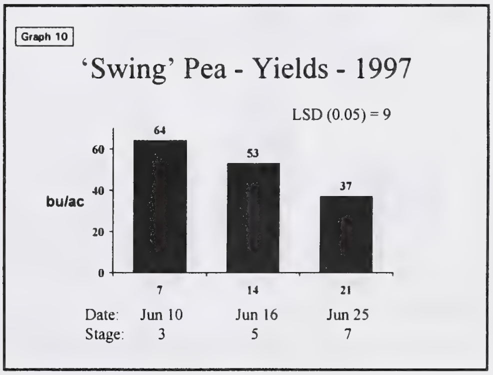
Lacombe (96-98), Peas
Lethbridge (96-98), Peas


Graph 8

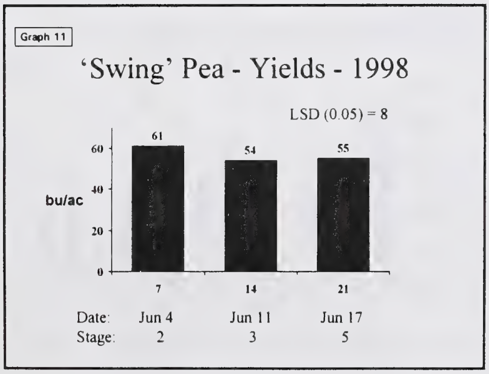
'Falcon' Barley - Yields - 1997


Graph 9

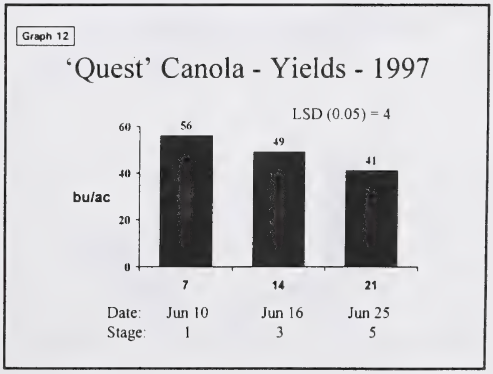
'Falcon' Barley - Yields - 1998


Graph 10

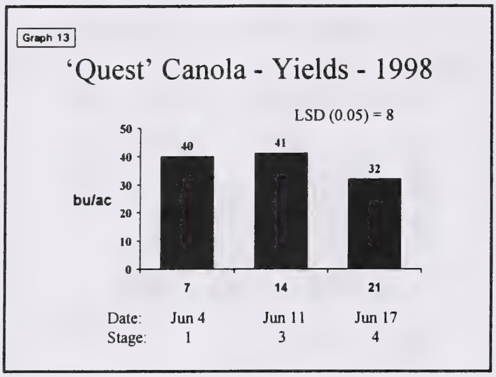
'Swing' Pea - Yields - 1997


Graph 11

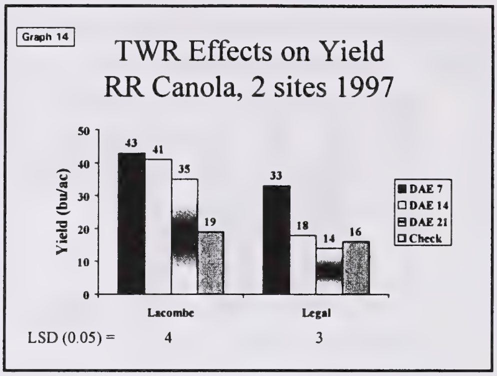
'Swing' Pea - Yields - 1998


Graph 12

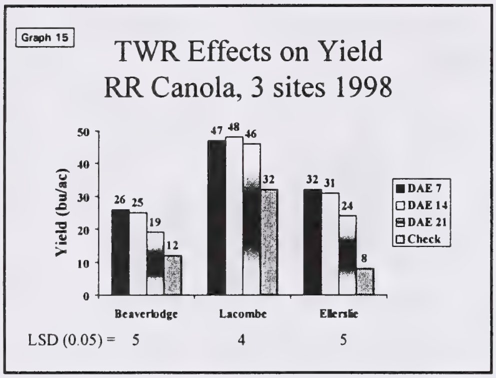
'Quest' Canola - Yields - 1997


Graph 13

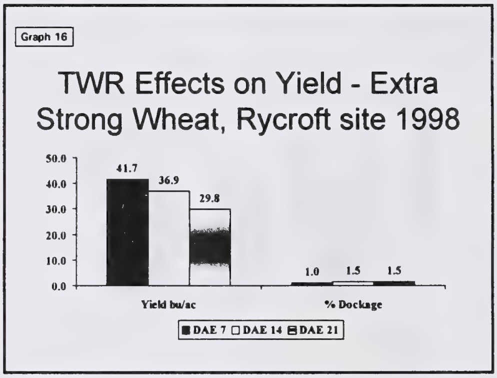
‘Quest’ Canola - Yields - 1998


Graph 14

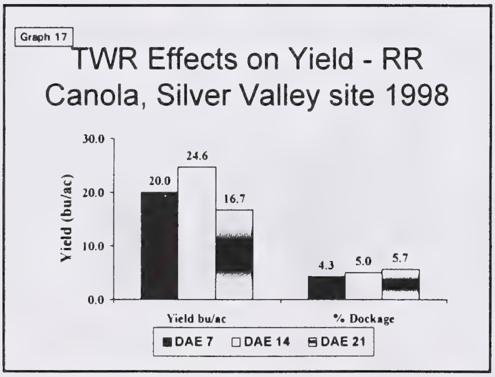
TWR Effects on Yield RR Canola, 2 sites 1997


Graph 15

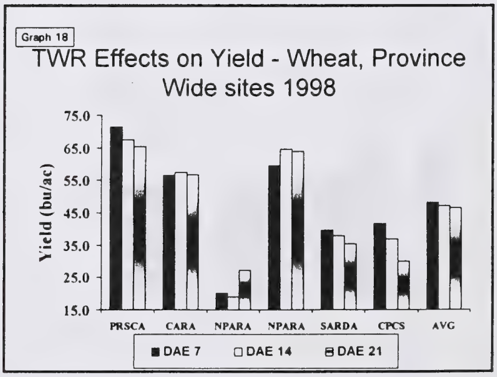
TWR Effects on Yield RR Canola, 3 sites 1998


Graph 16

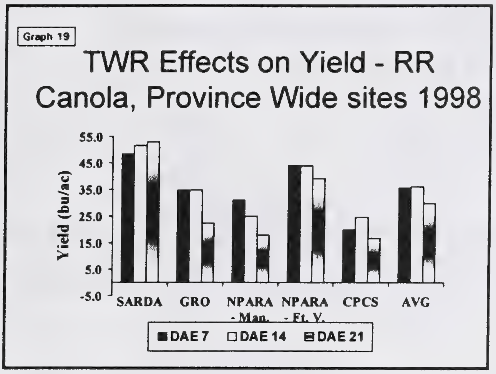
TWR Effects on Yield - Extra Strong Wheat, Rycroft site 1998


Graph 17

TWR Effects on Yield - RR Canola, Silver Valley site 1998


Graph 18

TWR Effects on Yield - Wheat, Province Wide sites 1998



Graph 19

TWR Effects on Yield - RR Canola, Province Wide sites 1998

What's New in Openers

Lawrence Papworth
Project Engineer
Alberta Agriculture, Food and Rural Development
Alberta Farm Machinery Research Centre
Lethbridge, Alberta

Recent emphasis at the Alberta Farm Machinery Research Centre (AFMRC) in the seeding and tillage area has been on research. The research has addressed the various types of openers and nitrogen types. I will discuss some of the past and current research projects at the AFMRC which address this topic.

A large project we completed in 1995 was using anhydrous ammonia with double shoot openers. Variables measured in the study were crop emergence and yield. In general we found that there was no consistent difference between using urea or anhydrous ammonia as the nitrogen source with double shoot openers. Four crop/sites out of twenty five had significantly higher yield using urea compared to anhydrous ammonia. These differences were attributed to losses of anhydrous ammonia during seeding. There were also some significant differences among the various openers in the study but no trends were consistent across all the sites.

In 1996 a project was completed using anhydrous ammonia in both the hot and cold flow forms as the nitrogen source with double shoot openers. The comparison was also made to urea. Again, there was no difference between the nitrogen sources. Opener systems used in the study were a side band, mid-row bander, sweep and fertilizer tube and conventional tillage seeding system. The sweep and fertilizer tube resulted in significantly less emergence than the other opener systems. There was no significant crop yield difference among the opener systems.

In 1997 a study was started to determine the effect of placing anhydrous ammonia with the seed. Urea and anhydrous ammonia were placed with canola and wheat seed using a narrow knife opener. The nitrogen fertilizer was applied at rates ranging from 0 to 168 kg/ha. The type of nitrogen placed with the seed did not effect the emergence or yield of canola and wheat except for a clay soil site which had higher canola and wheat emergence with the anhydrous ammonia nitrogen. One explanation for the higher emergence was that the clay soil furrow stayed open longer and allowed the anhydrous ammonia to move away from the seed.

The study of placing anhydrous ammonia with the seed was continued in 1998. A treatment of using a double shoot side band opener with urea was added to the study. Barley was the seed used in 1998. Results were similar to 1997 with no significant difference found between placing anhydrous ammonia or urea with the seed. In all cases the use of anhydrous ammonia as the nitrogen source resulted in lower emergence and yield than using urea as the nitrogen source. The drier planting and growing conditions than 1997 may have effected the performance of anhydrous ammonia as the nitrogen source. Figures 1 and 2 show the effect of the seeding system on the barley emergence and yield.

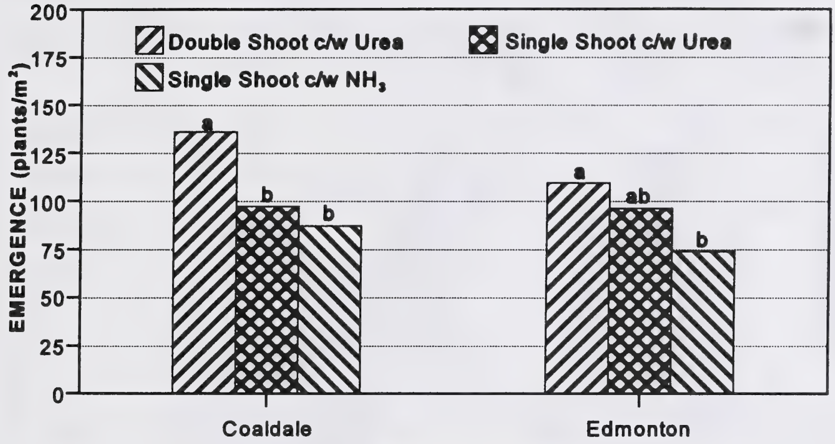


Figure 1. Effect of Seeding System on Barley Emergence, 1998.

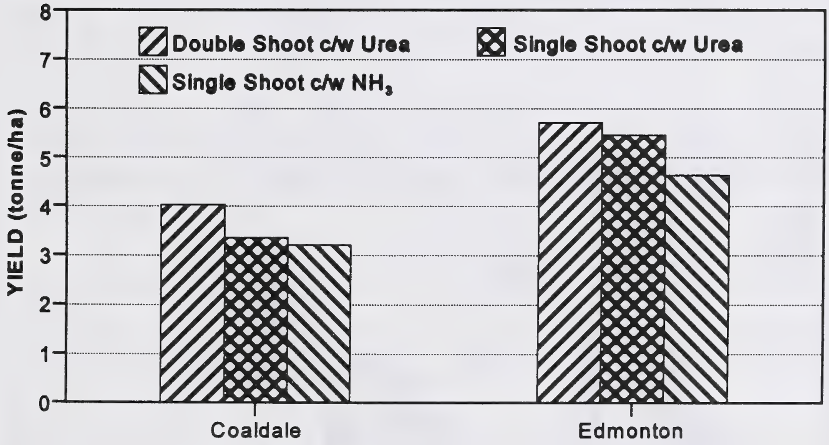


Figure 2. Effect of Seeding System on Barley Yield, 1998.

The analysis of the data for the study resulted in first order interactions. The combination of nitrogen rate and seeding system effected the emergence and yield of barley. Figure 3 shows the effect of nitrogen rate and seeding system on barley emergence at the Edmonton site. The emergence with the double shoot sideband opener remained constant as the nitrogen rate was increased but the emergence with the single shoot openers dropped as the nitrogen rate was increased.

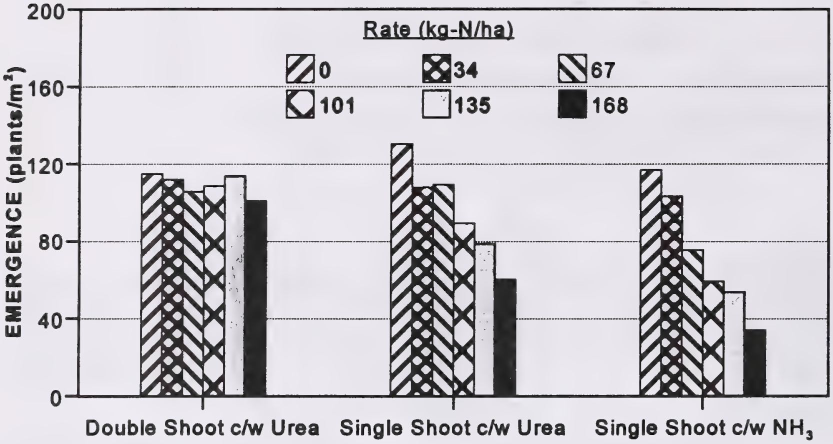


Figure 3. Effect of Nitrogen Rate and Seeding System on Barley Emergence - Edmonton, 1998.

Figure 4 shows the effect of nitrogen rate and seeding system on barley yield at the Edmonton site. The yield increased as the nitrogen rate increased but peaked sooner with the single shoot anhydrous ammonia than the other two seeding systems. We plan to continue this project in the future.

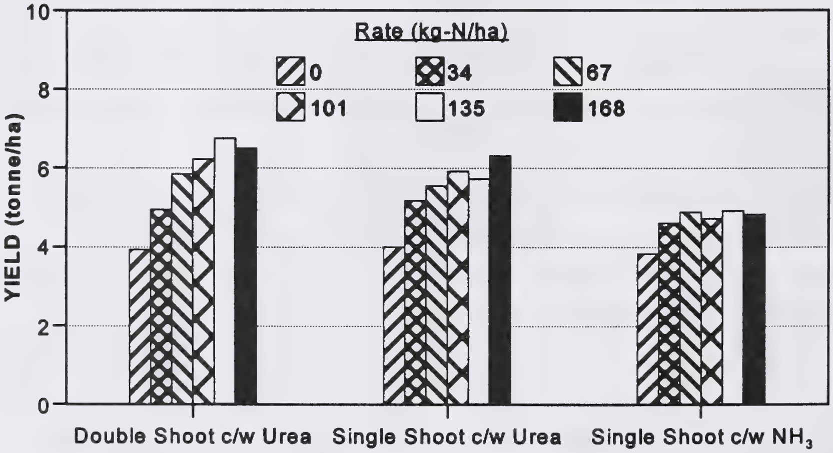


Figure 4. Effect of Nitrogen Rate and Seeding System on Barley Yield - Edmonton, 1998.

Another study started in 1998 was comparing liquid fertilizer to granular urea as the nitrogen source for four different seeding systems. The seeding systems used in the study were a side band opener with low separation, a side band with high separation, a ribbon opener and a narrow knife opener. The ribbon opener placed the seed and fertilizer in wide band. The narrow knife opener placed the seed and fertilizer in a narrow row. The side band opener with low separation was fabricated by Flexi-coil to place the seed and fertilizer closer together. Figure 5 shows the effect of fertilizer type on barley emergence. There was no difference in emergence between the crops fertilized with liquid or granular urea fertilizer.

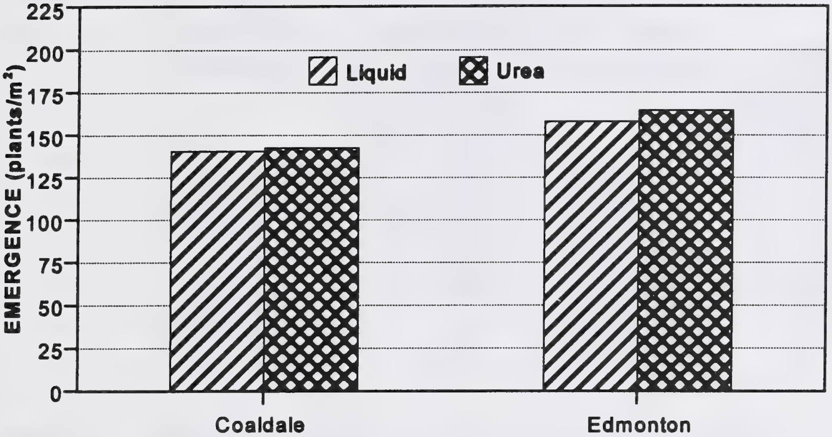


Figure 5. Effect of Fertilizer Type on Barley Emergence, 1998.

Figure 6 shows the effect of fertilizer type on barley yield. At the Coaldale site the liquid fertilizer yielded significantly higher than the urea fertilizer. There was no significant difference at the Edmonton site. The drier growing conditions at the Coaldale site may be the reason for the yield difference.

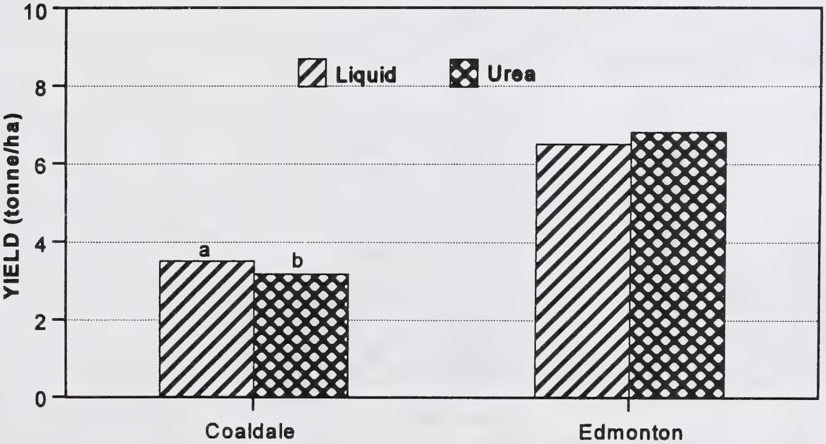


Figure 6. Effect of Fertilizer Type on Barley Yield, 1998.

Figure 7 shows the effect of opener type on barley emergence. At both sites the use of the narrow knife opener resulted in significantly lower emergence than the other three openers.

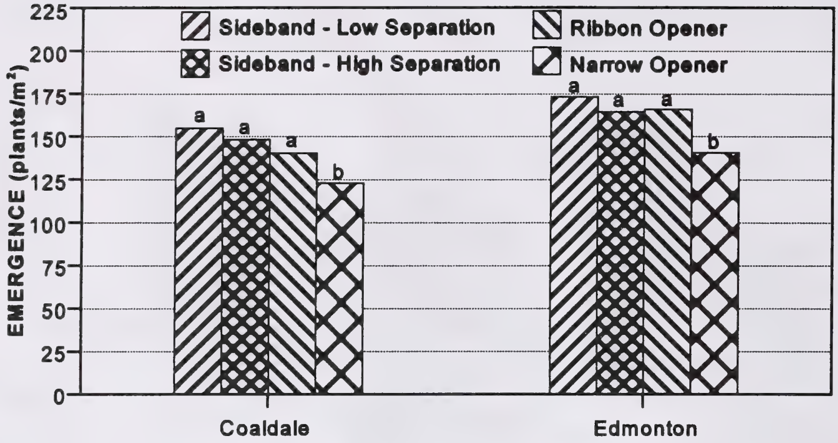


Figure 7. Effect of Opener on Barley Emergence, 1998.

Figure 8 shows the effect of opener type on barley yield. There was no difference among the openers at the Edmonton site. At the Coaldale site the narrow knife opener yielded significantly lower than the side band opener with low separation. The side band opener with low separation resulted in higher emergence and yield than the side band opener with high separation. One explanation for this may be the better quality seedbed with the side band low separation opener.

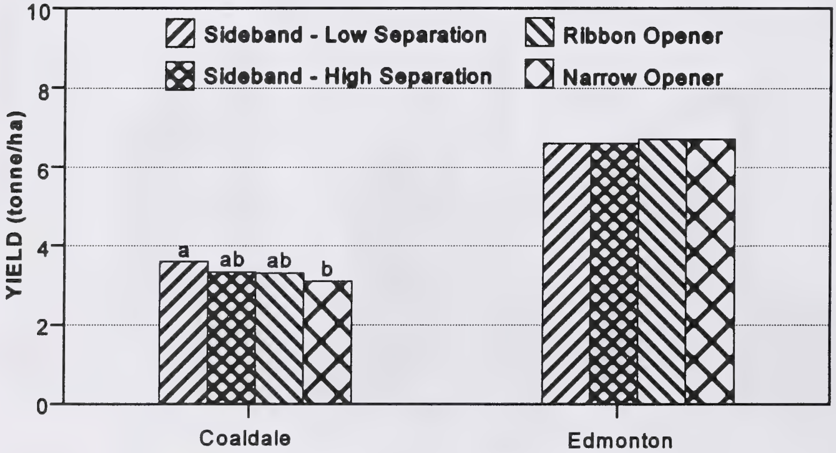


Figure 8. Effect of Opener on Barley Yield, 1998.

The analysis of the data for the Edmonton site resulted in first order interactions. Figure 9 shows the effect of fertilizer type and opener on barley emergence at the Edmonton site. The use of urea fertilizer resulted in varied emergence with the side band low separation opener the highest and the narrow knife opener the lowest. The use of liquid fertilizer resulted in constant emergence among the openers except for the narrow knife opener which was lower.

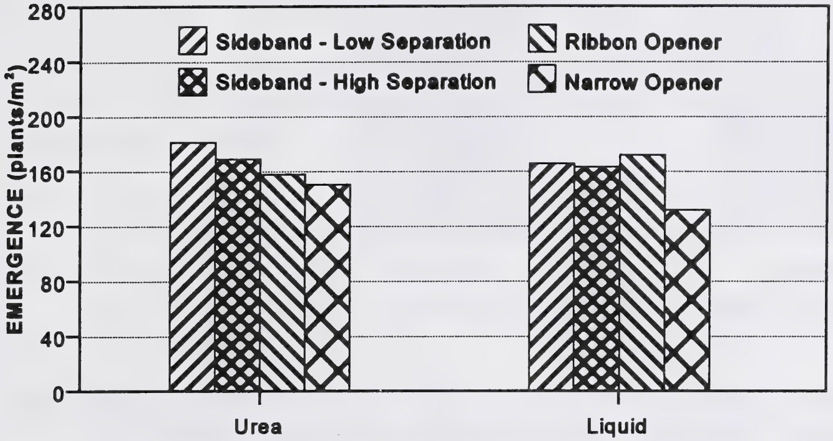


Figure 9. Effect of Fertilizer Type and Opener on Barley Emergence - Edmonton, 1998.

ROW SPACING

There are many advantages to wider row spacings. A few of the advantages are better residue clearance, reduced power requirements, reduced soil disturbance and lower initial seeder cost. Many producers have switched to wider row spacings and have found no reduction in yield.

Research completed on row spacing at Indian Head, Saskatchewan shows no reduction in yield when using wider row spacings such as 30 cm instead of the narrow row spacings such as 20 cm. The AFMRC started a row spacing project in 1998 to verify the results in Alberta that were obtained at Indian Head . The variables in the project are three row spacings: 20, 25 and 30 cm and three seed rates: low, medium and high. The seed used in 1998 was barley. Figure 10 shows the effect of row spacing on barley yield. There was no significant differences among the yields obtained with the different row spacings at the Coaldale site. There was a significant difference at the Edmonton site. The 20 cm row spacing resulted in significantly higher barley yield than the 30 cm row spacing.

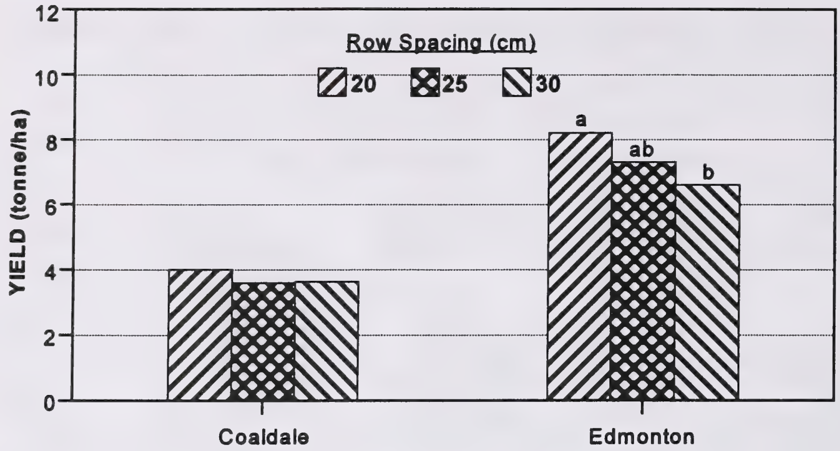


Figure 10. Effect of Row Spacing on Barley Yield, 1998.

Figure 11 shows the effect of seed rate on barley yield. There was no yield difference among the three seed rates at both sites. The project will be continued over the next few years.

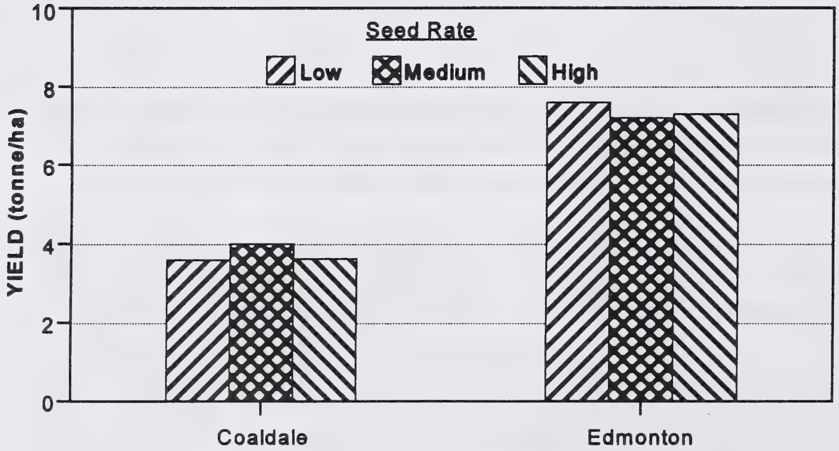


Figure 11. Effect of Seed Rate on Barley Yield, 1998.

Opener wear has been an issue with openers over the years. Manufacturers have addressed the issue by changing metal mixtures and improving the wear characteristics. Carbide tips are also used by manufacturers to increase opener wear. The carbide tips are expensive but greatly increase opener wear.

Another opener we have recently worked with is the Burr Packing System. This is really a packing system but the opener is an integral part. The system uses a burr to pack the seed instead of a wheel packer. The advantage to this system is they can be used on an air seeder and will

direct pack the seed.
The system worked well for a project we completed two years ago. The system has been modified and changed over the last two years.

One opener that we have not worked with is the Gray Seeding System. This opener is similar to the Anderson opener but built heavier and with hardened or carbide wear surfaces.

I would like to thank the following groups and companies for their cooperation in the research projects completed over the last three years. Cooperators for the project completed in 1995 are not listed due to space:

Agrium
Alberta Conservation Tillage Society Research Foundation
Bourgault
Neil Clark of DynAgra
Flexi-coil
Gen Manufacturing
Prairie Seeds
Simplot
University of Alberta
Zeneca

Benefits and Risks of Fall and Early Spring Seeding

Roger Andreiuk
Cereal and Oilseed Specialist
Alberta Agriculture, Food and Rural Development
Leduc, Alberta

Fall and Early Spring Seeding

- Background
- Research results

- 1997 Survey (22 seeded fall '96 & 4 seeded early spring '97)

Background for previous fall seeded crop failures

- High fall soil moisture conditions
- Heavy weed populations
- Fall germination
- Spring flooding
- Winter chinooks followed by -30C
- Spring soil crusting
- Seedling blight

Advantages of Fall Seeding

- reduced fall frost risk - 3 weeks earlier
- Argentine vs Polish in short season areas
- early season moisture ulitilization
- good fit with direct seeding systems
- cooler temperatures during flowering and seed set

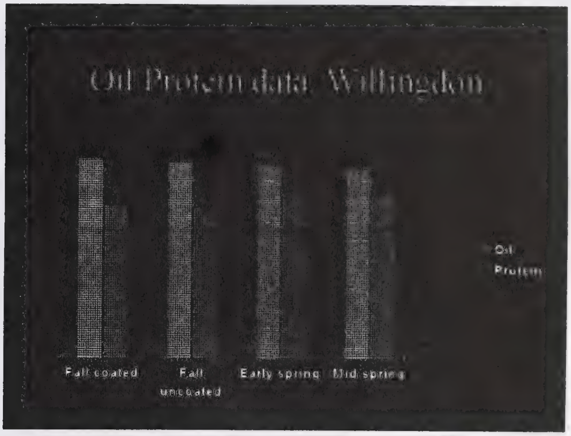
Advantages

- oil content appears to be higher 1 - 2%
- improved marketing opportunities
- reduced insect damage may be possible ??
  - Bertha, Lygus, Diamond Back in August
- reduced disease losses from sclerotinia, blackleg and alternaria black spot - ??

Oil & Protein ??
Willingdon data (one year - one site)

- 1997

1997	Oil %	Protein %
Fall Coated	51.11	38.92
Fall Uncoated	50.42	38.34
Early spring	49.74	42.41
Mid spring	48.91	42.11



Advantages

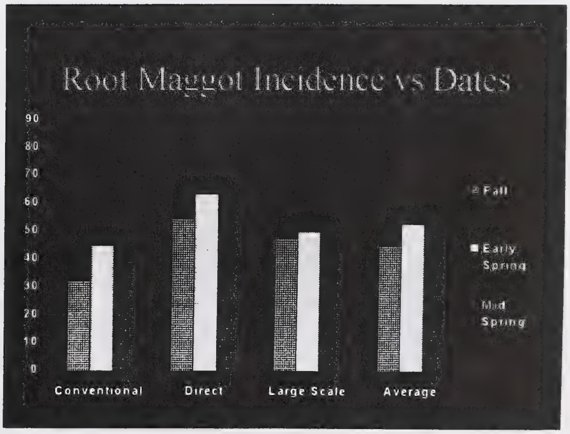
- early weed competition
- better weed control options with HTC varieties
- an early extended harvest (if you want to harvest that long)

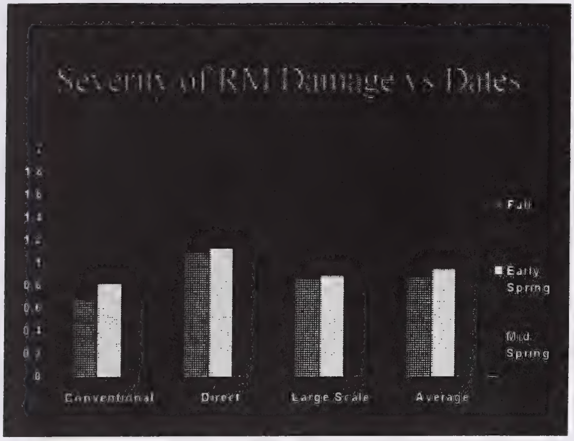
Disadvantages of Fall Seeding

- poor stands due to fall germination
- poor stands due to winter chinooks causing germination
- early spring frost damage
- Increased potential for cabbage seed pod weevil
- increased flea beetle damage due to early emergence

Disadvantages

- increased potential for root maggots ??
- spring water ponding
- hill tops - winter seed/soil erosion
- extra costs to HTC technology ???
- weed spraying vs seeding cereals
- swathing / combining vs hay or silage

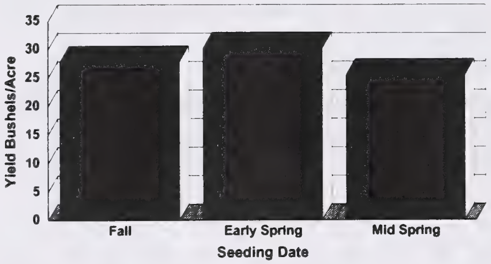




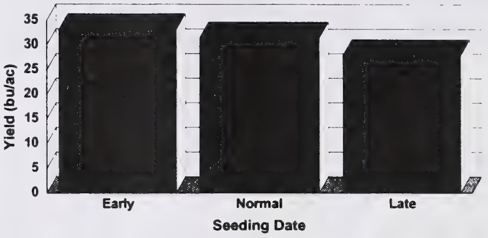
Ranges of critical growth stages for seeding date trials at Scott

Growth Stage	Fall Seeded	Early Spring Seeded	Mid Spring Seeded
Seeding Date	Oct 27 - Oct 31	Apr 25 - May 2	May 9 - May 23
Emergence	Apr 23 - May 1	May 9 - May 12	May 18 - May 29
50% Flower	June 11 - June 16	June 21 - June 27	June 23 - July 9
Swath	July 25 - Aug 3	July 29 - Aug 11	Aug 9 - Aug 19
Combine	Aug 5 - Aug 15	Aug 8 - Aug 16	Aug 23 - Aug 27

Average Seeding Date Yield - Scott, 1994 - 96



Early seeding - 16 trials 96/97



Canola Council of Canada - Western Canada

1997 Survey - Fall & Early Spring Seeding

- 22 growers fall seeded
  - 19 were successful
  - 3 were not due to either very poor stands or due to herbicide damage
- Limited data on Early Spring Seeding
  - only 4 growers surveyed
- most in the Black soil sone
- 6 direct seeders

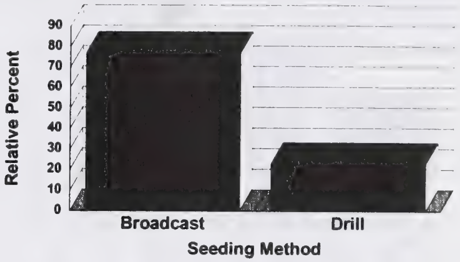
Survey - Varieties Used in Fall Seeding

Innovator	30%
Quantum	25%
45A71	20%
Quest	10%
Legacy	5%
Legend	5%
Garrison	5%

Seeding Date

- Most were sown between October 25 and November 2
- Soil Temperature @1" = 1 to 3 C
- Most seedbeds froze 1 to 5 days after seeding
- Most fields were covered by snow within a week of seeding

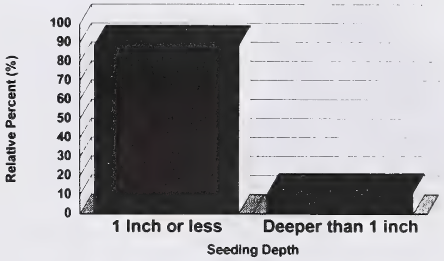
Seeding Methods Used



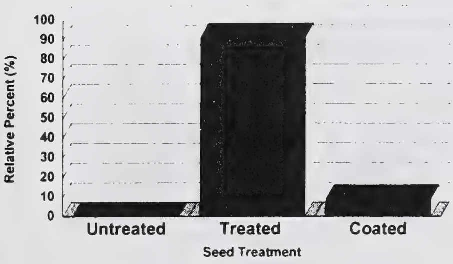
Rate of Seeding

- Average seeding rate = 7 lbs/acre
- Range = 4.5 to 9 lbs/acre

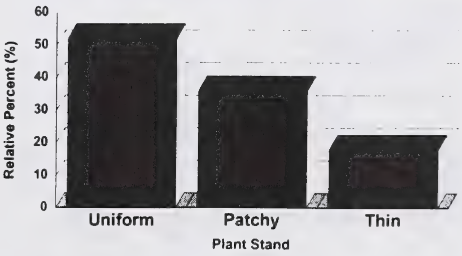
Seeding Depth



Seed Treatments



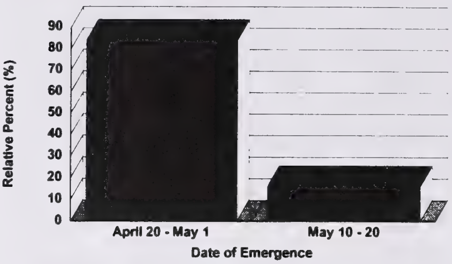
Plant Stand Establishment



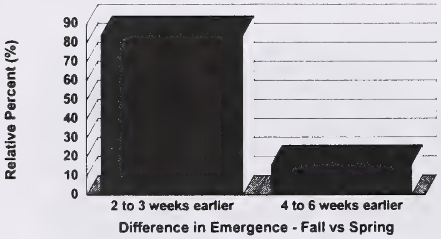
Plant Stand

- Three quarters reported a light plant stand of 3 to 4 plants per square foot
- The rest reported normal to heavy plant stands

Date of Emergence



Difference in Date of Emergence Compared to Spring Sown Canola



4-6 Weeks - Spring sown canola under very dry conditons

Spring Frosts

- Only one grower reported no spring frost on plants in the fall sown emerging field
- Frosts ranged from -2 to -9C on emerged seedlings (cotelydon to 3 leaf)
- Only 14% reported visible frost damage on seedlings - growers felt this slowed down the crop somewhat but otherwise caused little damage

Fertility

- Only 18% soil tested their field before seeding
- Nitrogen
  - All applied nitrogen
  - Average 70 lb/acre - Range 50 to 95 lb/acre
  - Most was fall applied
  - 37% of survey broadcast their dry fert.
  - 37% of survey banded their dry fert.
  - Rest was Anhydrous or manure

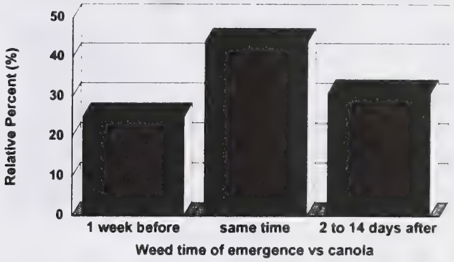
Fertility

- Phosphorus
  - All applied phosphorus
  - Average 28 lb/acre - Range 17 to 40 lb/acre
  - 50% applied P with the seed
  - 33% broadcast P in the fall
  - 17% banded P

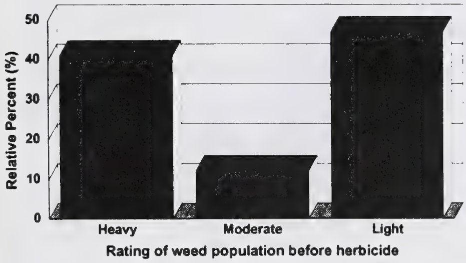
Fertility

- Potassium
  - 45% applied K
  - Average 22 lb/acre - Range 10 to 40 lb/acre
- Sulphur
  - 64% applied S
  - Average 20 lb/acre - Range 12 to 35 lb/acre
  - 60% was in the sulphate form (hooray!!)
  - 40% was elemental

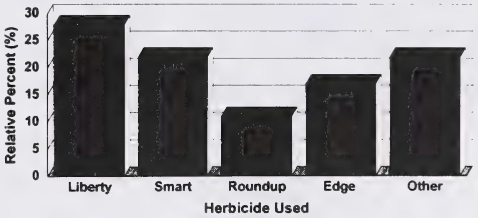
Time of Weed Emergence



Weediness in the Spring

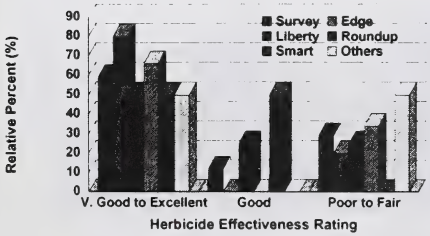


Herbicides Used



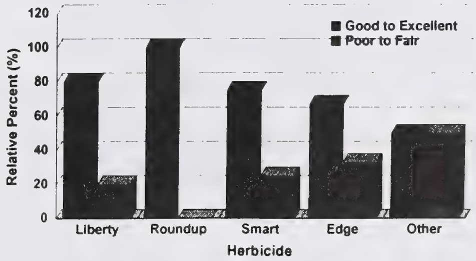
Other = combinations of Lontrel, Muster &/or Poast
Liberty/Venture(2), Smart/Edge(1), Edge/Assure/Lontrel(1)

Rating of Herbicide Effectiveness

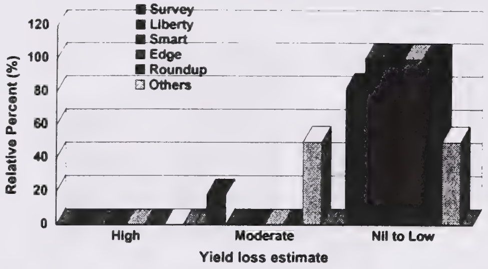


Of those rating poor to fair - 80% rated yield losses as light

Herbicide Effectiveness



Yield Loss Estimates due to Weeds



Weed Problems for the 18% that reported moderate yield losses

1st major weed	2nd major weed	3rd major weed
Stinkweed (75%)	Hempnettle-25%	Buckwheat-25%
Hempnettle(25%)	Chickweed-25%	Chickweed-25%
	Vol. Barley-25%	Quackgrass-25%
	Canada thistle-25%	None -25%

Weed Problems for those reporting nil to light yield losses

1st major weed	2nd major weed	3rd major weed
Stinkweed(50%)	Cleavers (21%)	None -29%
Vol.Barley(14%)	Hempnettle-14%	Wild Oats - 29%
Wild Oat (14%)	Lamb's - 14%	Quack - 14%
Sowthistle(21%)	Stinkweed -7%	Pigweed - 7%
	Wild oats - 7%	Cleavers - 7%
	Vol. Barley - 7%	Buckwheat - 7%
	Sow thistle - 7%	Shepard's - 7%
	Stork'sbill - 7%	
	Dandelion - 7%	
	None - 7%	

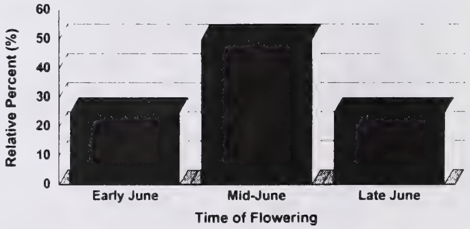
Insect Problems

- 77% did not report insects as a problem
- Insects reported were:
  - Lygus, Diamond backed moths, & turnip beetles
- Growers with insects reported yield loss estimates as nil to very low.

Disease Problems

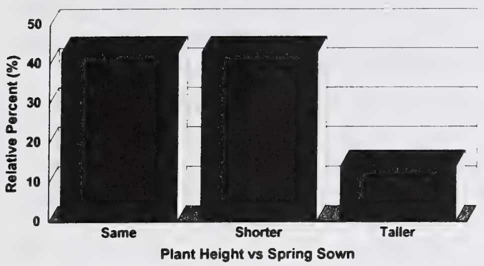
- 69% reported no disease problems
- Of the 31% who reported a disease problem - the main disease was sclerotinia.
  - Only one grower reported high yield losses of 9-10 bu/ac
- Many growers commented that they felt that there was much less sclerotinia in fall seeded than for normal spring sown canola

Time of Flowering



Rated as being 2 to 3 weeks earlier than spring sown

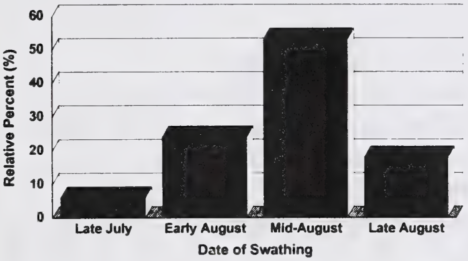
Plant Height



Plant Lodging

- Only one field reported lodging as a problem - this field was heavily manured

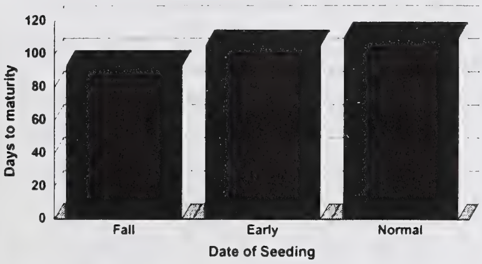
Swathing Date



Swathing Date

- On average the swathing date was 2 to 3 weeks earlier than with spring sown crops
- *69% swathed late at 40% seed color change* or more - Crop caught them by surprise
- Only one grower reported an August frost which caused no damage

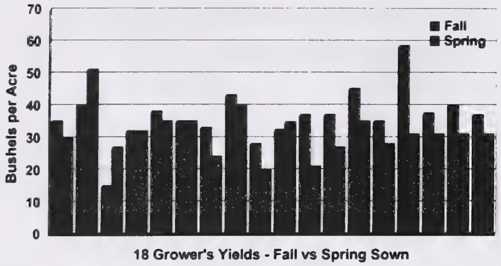
Maturity Advantage



Combining Date

- 63% combined their fall seeded crop in late August - Most of the others said that their crop was ready to combine in August
- Date of combining was 2 to 3 weeks earlier than spring sown canola
- Most of the fall sown canola was harvested with a seed moisture content of less than 9%

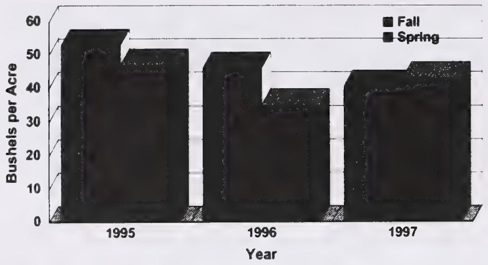
Fall Seeded Yields



Yields of Fall Seeded vs Normal Spring

- 78% of the fall seeded fields yielded more than normal spring sown fields (of which 84% was sown before May 15th)
- Average fall seeded yield was 37.4 bu/acre with a range of 15 to 58.5 bu/acre
- Ave spring was 32.2 bu/acre - range 20-51bu/acre
- 86% of the fall seeded fields were successful
  - 2 failures due to deep seeding
  - 1 failure due to herbicide damage

Three Year Comparison - One Grower in the Camrose Area



Early Spring Sown Canola

- 75% Broadcast seeded - 25% hoe-press
- Seeding dates:
  - mid-April in southern Alberta
  - late April to early May in central Alberta
- Seedbed temperatures ranged from 2C to 8C
- Emergence was 1 to 2 weeks before normal seeded canola
- 50% of the fields had a frost but no damage

Early Spring

- Fertility was high - 70 N, 20 P, 0 K, and 50% applied S
- Reasonable weed control was achieved
- No losses from diseases - one applied a fungicide
- Flowering was 1 week earlier than normal canola
- Swathing:
  - 50% swathed in early August
  - 50% swathed in late August early September

Early Spring

- Yields ranged from 25 to 56 bu/acre
- Average was 41 bu/acre vs 31 for normal spring
- Dockage was light 3 to 4%
- All graded a CC#1 - no green seed problem

Recommendations

- Avoid fields prone to water ponding
- Avoid windswept exposed slopes
- Don't seed the whole farm the first time
- Use a HTC variety where warranted
- Know your weeds & herbicide timing
- Fall seed as late as you can (definition of late fall?? -- the day before winter!!)
- Spring seed as early as you can

Recommendations

- Apply recommended fertilizer -soil test -N:S ratio
- Increased seeding rate (+ 1 lb/ac)
- Seed shallow
- To-date most successes have been with broadcast seeding and most failures with deep seeding
- Packing may help for good seed to soil contact - Do Not Overpack

---

Recommendations

- Avoid tillage ridges at seeding which can slump over winter
- Use treated seed

Success or Failure ???????

- one-half million acres ???
- All the writing is not on the wall
- If you have doubts - SEED EARLY

Future Work

- producer survey (this spring -lot of acres tried fall '97)
- hormone treatment or coatings on seed
- long season varieties (high yielding)
- double cropping with Polish varieties
- seeding rates and timing
- fertility - placement and timing
- seeding methods

Climate Conditions in the Peace Region

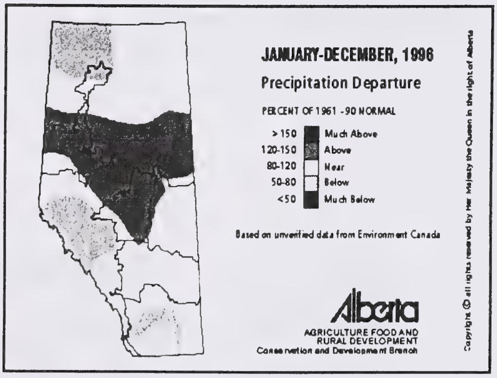
Shane Chetner
Weather Resource Technologist
Alberta Agriculture, Food and Rural Development
Leduc, Alberta

Presentation

- How wet was 1996/1997 ?
- How dry was 1998 ?
- Climate change
- Sources of weather forecasts - 1999
- Direct seeding in wet and dry years

How wet was 1996 ?

- Probability
- Peace River 1 in 47 years
- Ballater 1 in 125
- Grande Prairie 1 in 2
- High Level 1 in 1



JANUARY-DECEMBER, 1996

Precipitation Departure

PERCENT OF 1961 -90 NORMAL

> 150	■	Much Above
120-150	▨	Above
80-120	☐	Near
50-80	☐	Below
<50	■	Much Below

Based on unverified data from Environment Canada

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RURAL DEVELOPMENT
Conservation and Development Branch

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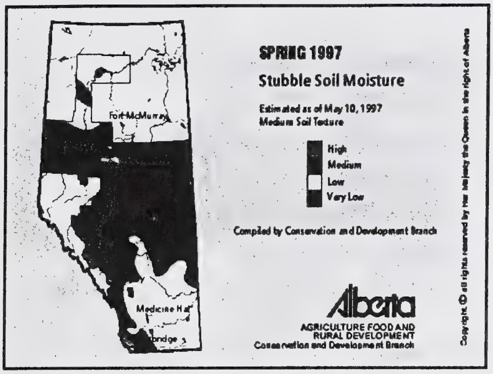
How wet was 1997 ?

- Probability
- Peace River 1 in 25 years
- Ballater 1 in 3
- Grande Prairie 1 in 3
- High Level 1 in 6



SPRING 1997

Stubble Soil Moisture

Estimated as of May 10, 1997
Medium Soil Texture

- High
- Medium
- Low
- Very Low

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Conservation and Development Branch

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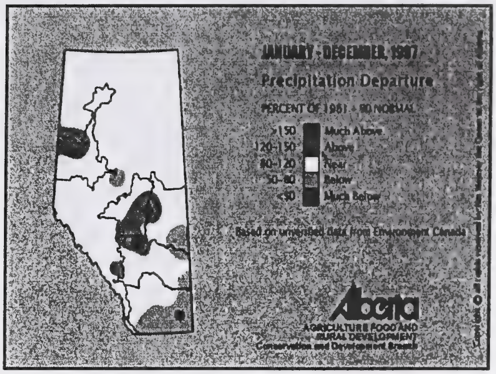

JANUARY - DECEMBER, 1997

Precipitation Departure

PERCENT OF 1961 - 90 NORMAL

>150	Much Above
120-150	Above
80-120	Near
50-80	Below
<50	Much Below

Based on unverified data from Environment Canada

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Conservation and Development Branch

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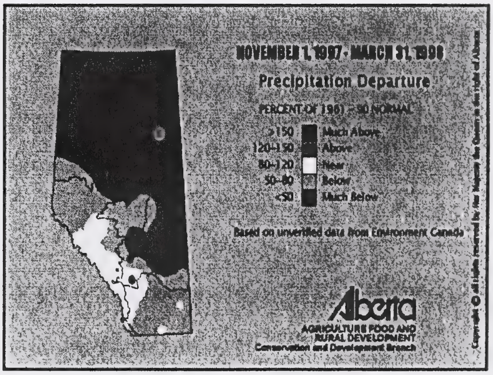
How dry was Alberta

in 1998 ?



NOVEMBER 1, 1997 - MARCH 31, 1998

Precipitation Departure

PERCENT OF 1961 - 90 NORMAL

>150	Much Above
120-150	Above
80-120	Near
50-80	Below
<50	Much Below

Based on unverified data from Environment Canada

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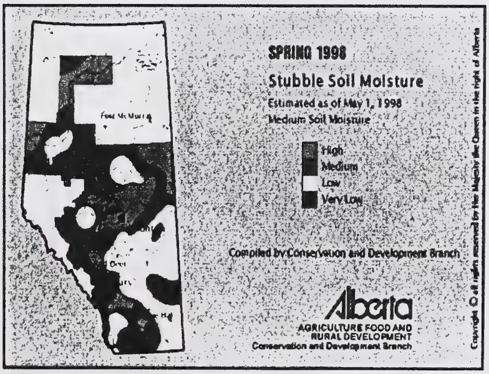

SPRING 1998

Stubble Soil Moisture

Estimated as of May 1, 1998
Medium Soil Moisture

- High
- Medium
- Low
- Very Low

Compiled by Conservation and Development Branch

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Conservation and Development Branch

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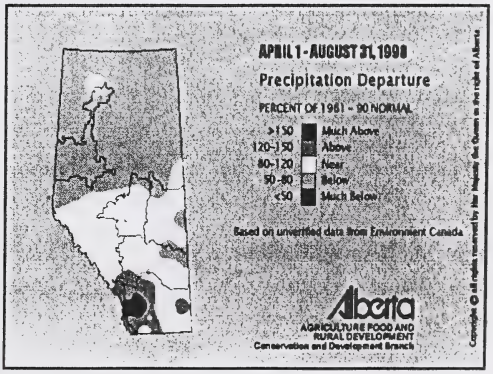

APRIL 1 - AUGUST 31, 1998

Precipitation Departure

PERCENT OF 1961 - 90 NORMAL

>150	Much Above
120-150	Above
80-120	Near
50-80	Below
<50	Much Below

Based on unverified data from Environment Canada

Alberta
AGRICULTURE FOOD AND RURAL DEVELOPMENT
Conservation and Development Branch

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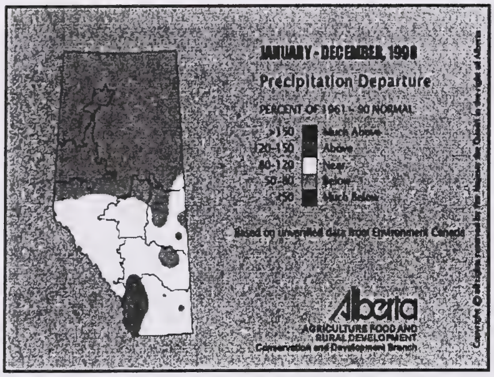


JANUARY - DECEMBER, 1998

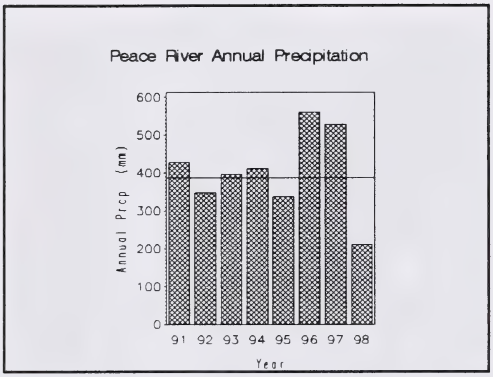
Precipitation Departure

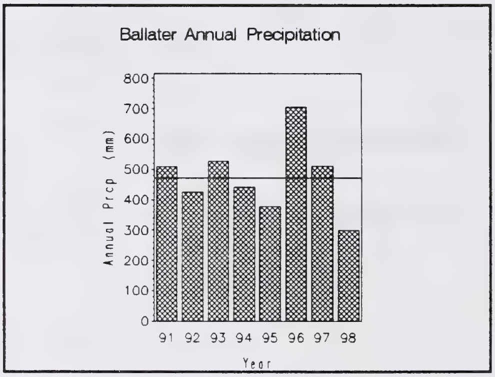
Based on unverified data from Environment Canada

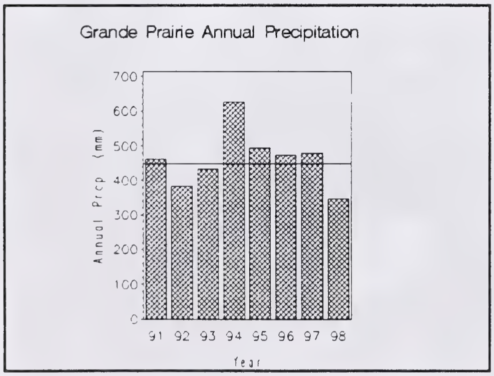
Alberta
AGRICULTURE FOOD AND RURAL DEVELOPMENT
Conservation and Development Branch

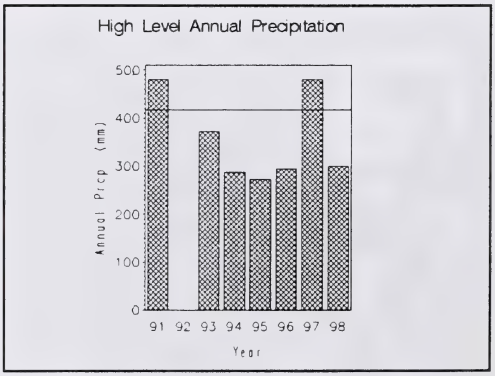
How dry was 1998 ?

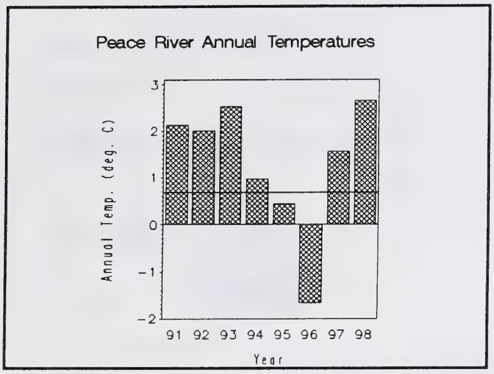
Probability
Peace River 1 in 71 years
Ballater 1 in 27
Grande prairie 1 in 7
High Level 1 in 23



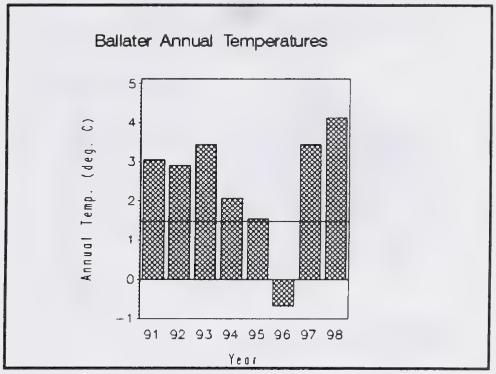




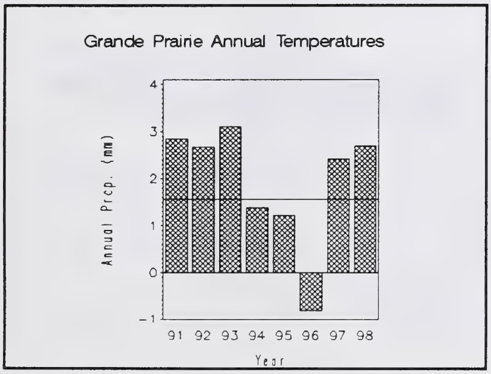




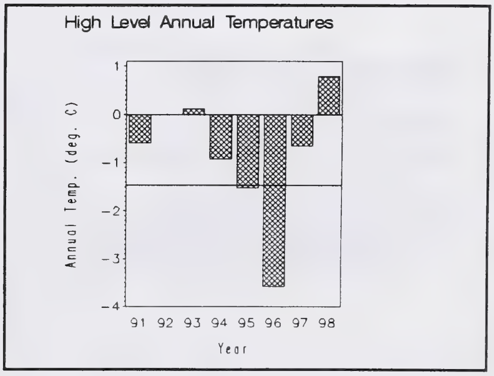
Peace River Annual Temperatures



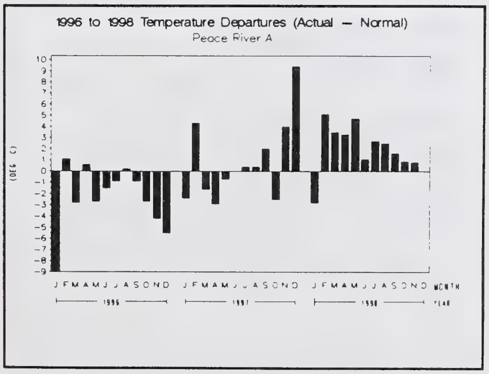
Ballater Annual Temperatures



Grande Prairie Annual Temperatures



High Level Annual Temperatures



1996 to 1998 Temperature Departures (Actual — Normal)

Peace River A

How warm/dry was Canada in 1998 ?

1998 warmest year in last 50

2.5°C above normal

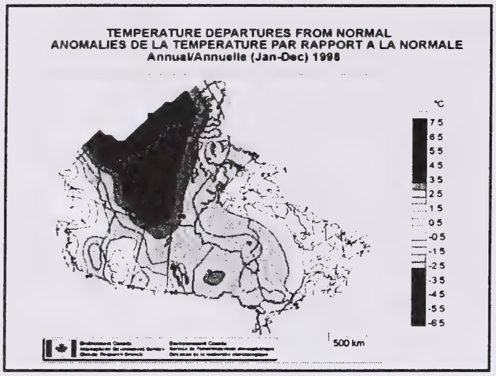
second warmest winter

warmest spring, summer and autumn

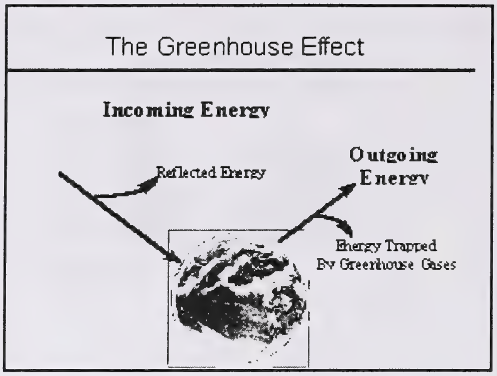
2.7% less precipitation

9th driest year on record

Source: Environment Canada



TEMPERATURE DEPARTURES FROM NORMAL
ANOMALIES DE LA TEMPERATURE PAR RAPPORT A LA NORMALE
Annual/Annuelle (Jan-Dec) 1998



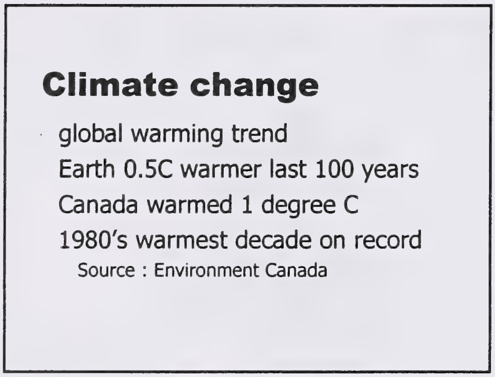
The Greenhouse Effect

Incoming Energy

Reflected Energy

Outgoing Energy

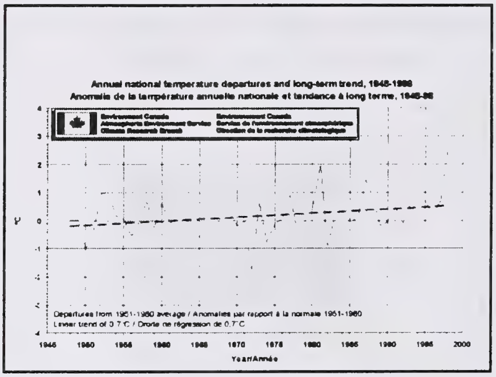
Energy Trapped
By Greenhouse Gases



Climate change

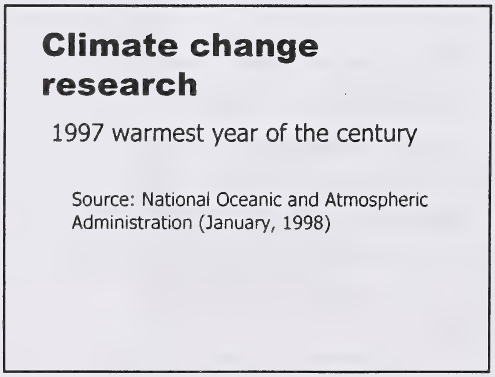
- global warming trend
- Earth 0.5C warmer last 100 years
- Canada warmed 1 degree C
- 1980's warmest decade on record

Source : Environment Canada



Annual national temperature departures and long-term trend, 1948-1998
Anomalie de la température annuelle nationale et tendance à long terme, 1948-98

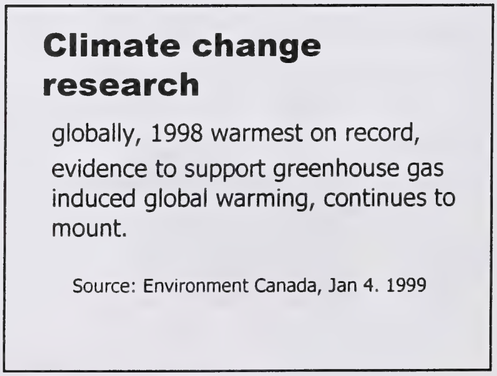
Departures from 1951-1980 average / Anomalies par rapport à la normale 1951-1980
Linear trend of 0.7°C / Droite de régression de 0.7°C



Climate change research

1997 warmest year of the century

Source: National Oceanic and Atmospheric Administration (January, 1998)



Climate change research

globally, 1998 warmest on record, evidence to support greenhouse gas induced global warming, continues to mount.

Source: Environment Canada, Jan 4. 1999

Climate change research

- night time temperatures over land increased
- seasonal phase change
- winter getting warmer

Source: Environment Canada

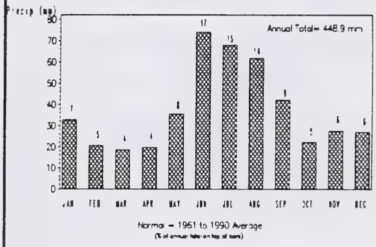
Climate change research

- spring comes earlier
- summer and fall no change
- impact of climate change on Agriculture
- longer growing season

Source: Environment Canada

Sources of 1999 Weather Forecasts

- historical climate information
- long range forecasts



Most precipitation falls during the summer

Grande Prairie A

Normal = 1961 to 1990 Average

(% of annual total on top of bars)

General Climate observations

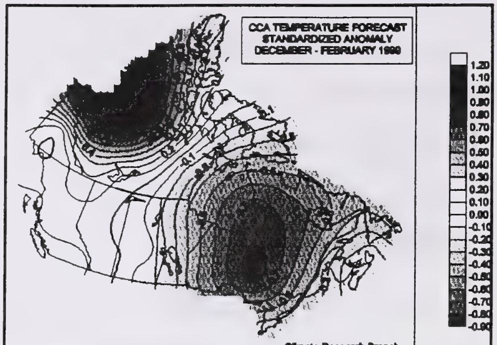
- general weak trend in all seasons
- warm and dry - example 1998
- cold and wet - example 1996
- experience at your farm

Long range forecasts sources:

- Canadian Institute for Climate Studies- user pays
- Environment Canada - spring links not working
- NOAA - data ends at 49 parallel

Environment Canada:

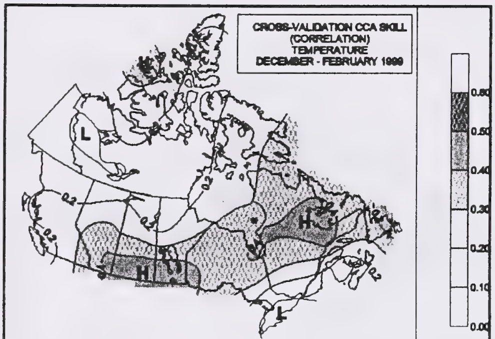
- spring, 1999
- summer, 1999
- fall, 1999



CCA TEMPERATURE FORECAST
STANDARDIZED ANOMALY
DECEMBER - FEBRUARY 1999

Contour Interval: 0.1

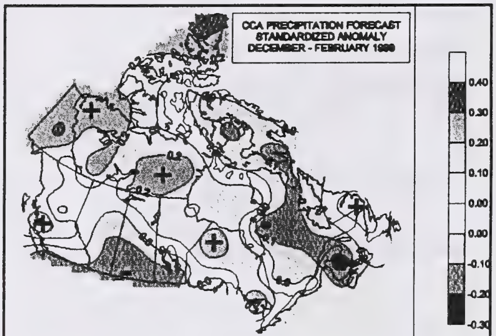
Climate Research Branch
Environment Canada



CROSS-VALIDATION CCA SKILL
(CORRELATION)
TEMPERATURE
DECEMBER - FEBRUARY 1999

Contour Interval: 0.1

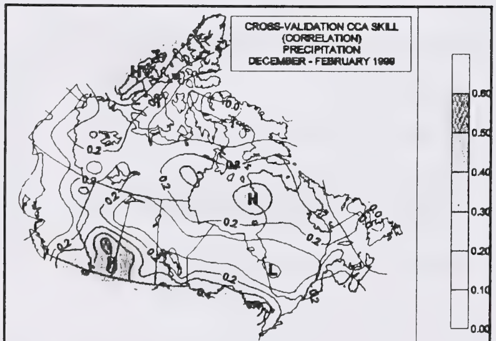
Climate Research Branch
Environment Canada



CCA PRECIPITATION FORECAST
STANDARDIZED ANOMALY
DECEMBER - FEBRUARY 1999

Contour Interval: 0.1

Climate Research Branch
Environment Canada

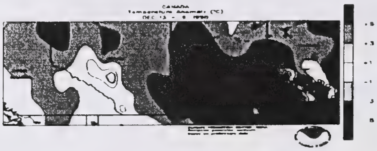


CROSS-VALIDATION CCA SKILL
(CORRELATION)
PRECIPITATION
DECEMBER - FEBRUARY 1999

Contour Interval: 0.1

Climate Research Branch
Environment Canada

This forecast was 10 to 15C wrong



Impact of direct seeding

direct seeding has impact on soil

soil tilth aggregation leads to

- more percolation into soil
- more air in soil
- during wet years better drainage and increased aeration
- lead to better crops
- not researched - observed
- Source: Al Howard

Impact of direct seeding

be ready to seed early

top up dugouts by spring

conserve water

Conclusion

1996 precipitation well above normal

1997 precipitation above normal

1998 was well below normal

1997 and 1998 warmest in 50 years

Conclusion (continued)

Climate change evidence growing

1999 weather forecasts

climate - more reliable

long range forecasts - less reliable

Alberta Agriculture Internet site

weather and climate information

http://www.agric.gov.ab.ca

Long range weather forecasts

http://www.agric.gov.ab.ca

http://www.cmc.ec.gc.ca/climate/otherlinks.htm

http://nic.fb4.noaa.gov/index_frame.html

http://hpccsun.unl.edu/WEATHER/HTML/ll_forecasts.html

http://nic.fb4.noaa.gov:80/products/

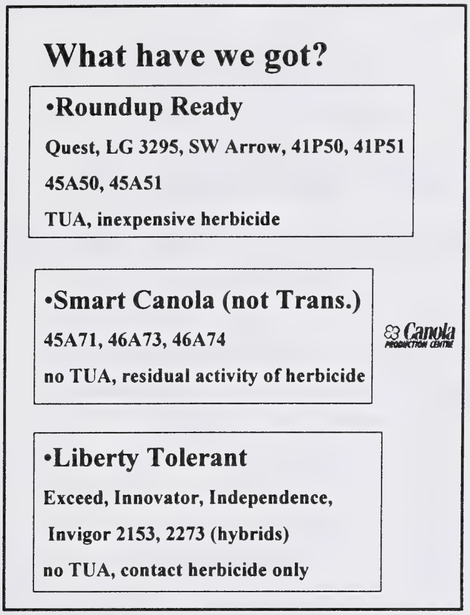
Canola Council of Canada

Transgenic Canola

Garry Coy
Agronomist
Canola Council of Canada
Wanham, Alberta

- What have we got now?
- When are they appropriate?
- Pros and Cons?
- What does the future hold?

Canola
PRODUCTION CENTRE



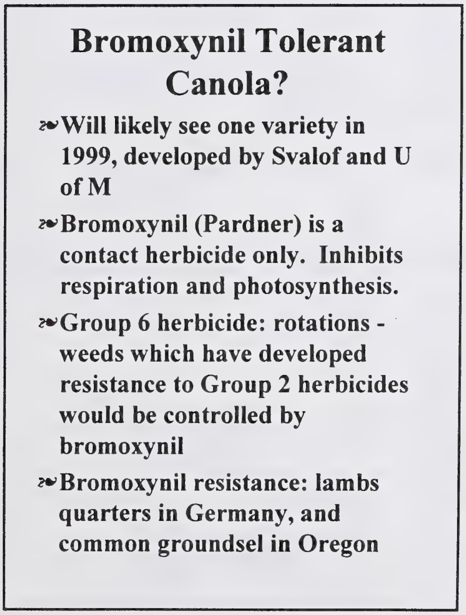
What have we got?

- **Roundup Ready**
  Quest, LG 3295, SW Arrow, 41P50, 41P51
  45A50, 45A51
  TUA, inexpensive herbicide

- **Smart Canola (not Trans.)**
  45A71, 46A73, 46A74
  no TUA, residual activity of herbicide

- **Liberty Tolerant**
  Exceed, Innovator, Independence,
  Invigor 2153, 2273 (hybrids)
  no TUA, contact herbicide only

Canola
PRODUCTION CENTRE



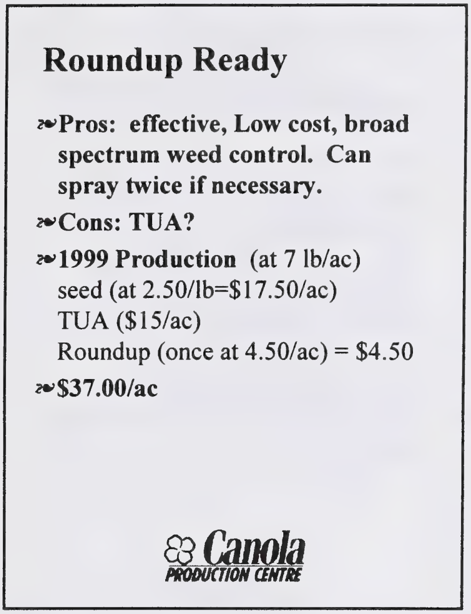
Bromoxynil Tolerant Canola?

- Will likely see one variety in 1999, developed by Svalof and U of M
- Bromoxynil (Pardner) is a contact herbicide only. Inhibits respiration and photosynthesis.
- Group 6 herbicide: rotations - weeds which have developed resistance to Group 2 herbicides would be controlled by bromoxynil
- Bromoxynil resistance: lambs quarters in Germany, and common groundsel in Oregon

Bromoxynil Tolerant Canola?

Weeds Controlled by Bromoxynil	**HTC**	**Conv.**	**Conv.**	**Conv.**	**HTC**	**HTC**	**HTC**
Group :	**Bromoxynil *6**	**Edge 3**	**Lontrel 4**	**Muster 2**	**Liberty 10**	**Odyssey 2**	**Roundup 9**
Bluebur	Yes						
Buckwheat	Yes						Yes
Night flowering catchfly	Yes						Yes
Scentless chamomile	Yes		Yes				
Cow cockle	Yes	Yes					Yes
Cocklebur	Yes						
Common Groundsel	Yes						
Kochia	Yes	Yes			Yes	Yes	Yes
Knawel	Yes						
Smartweed	Yes	Supp.		Yes	Yes	Yes	Yes
Lamb's Quarters	Yes	Yes			Yes	Yes	Yes
Wild Mustard	Yes			Yes	Yes	Yes	Yes
Stinkweed	Yes			Yes	Yes	Yes	Yes
Ragweed	Yes						
Russian Thistle	Yes	Yes			Yes	Yes	Yes
Redroot Pigweed	Yes	Yes		Yes	Yes	Yes	Yes
Nightshade	Yes	Supp.					

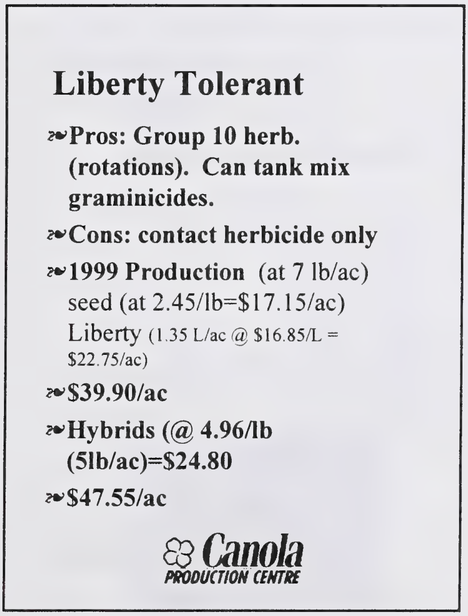
Weeds NOT Controlled by Bromoxynil	**HTC**	**Conv.**	**Conv.**	**Conv.**	**HTC**	**HTC**	**HTC**
Group :	**Bromoxynil * 6**	**Edge 3**	**Lontrel 4**	**Muster 2**	**Liberty 10**	**Odyssey 2**	**Roundup 9**
Cleavers	No	Supp.			Yes	Yes	Yes
Chickweed	No	Yes			Yes	Yes	Yes
Flixweed	No			Yes			
Bindweed	No						
N. Leafed Hawks beard	No						
Hemp nettle	No	Supp.		Yes	Yes	Yes	Yes
Shepherds purse	No				Yes	Yes	Yes
Sowthistle	No				Yes		Supp.
Corn spurry	No	Yes					Yes
Storks bill	No						
Canada Thistle	No		Yes		Supp.		Supp.



Roundup Ready

- **Pros: effective, Low cost, broad spectrum weed control. Can spray twice if necessary.**
- **Cons: TUA?**
- **1999 Production** (at 7 lb/ac)
  seed (at 2.50/lb=$17.50/ac)
  TUA ($15/ac)
  Roundup (once at 4.50/ac) = $4.50
- **$37.00/ac**

Canola PRODUCTION CENTRE



Liberty Tolerant

- **Pros: Group 10 herb. (rotations). Can tank mix graminicides.**
- **Cons: contact herbicide only**
- **1999 Production** (at 7 lb/ac)
  seed (at 2.45/lb=$17.15/ac)
  Liberty (1.35 L/ac @ $16.85/L = $22.75/ac)
- **$39.90/ac**
- **Hybrids (@ 4.96/lb (5lb/ac)=$24.80**
- **$47.55/ac**

Canola PRODUCTION CENTRE

Smart Canola

Pros: residual broad spectrum weed control. Can tank mix graminicides

Cons: residue restricts crop rotation schedule

1999 Production (bought before March 31) (at 7 lb/ac)

seed (at 2.00/lb=$14.00/ac)

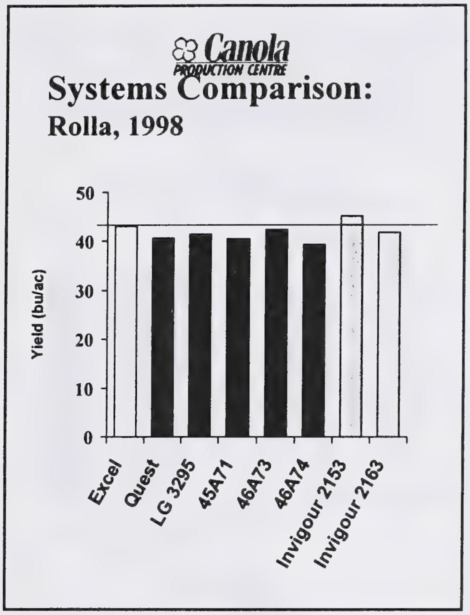
Odyssey (@17g/ac rate) = $24.48/ac

$38.48/ac

Canola PRODUCTION CENTRE

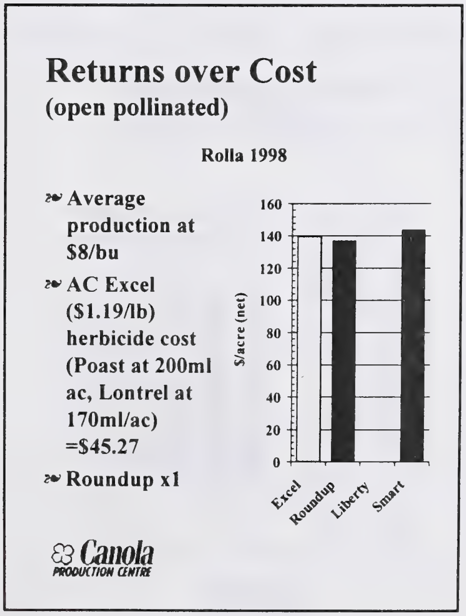
Comparison of Costs

Roundup Ready:	$37.00	
Liberty Link:	$39.90	open pol.
Liberty Link:	$47.55	Hybrids
Smart Canola:	$38.48	
Conventional	$45.27	AC Excel



Canola
PRODUCTION CENTRE

Systems Comparison:
Rolla, 1998



Returns over Cost
(open pollinated)

Rolla 1998

- Average production at $8/bu
- AC Excel ($1.19/lb) herbicide cost (Poast at 200ml ac, Lontrel at 170ml/ac) =$45.27
- Roundup x1

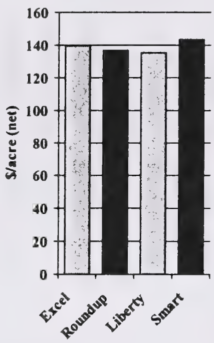
Canola
PRODUCTION CENTRE

Returns over Cost

(Hybrids)

Rolla 1998

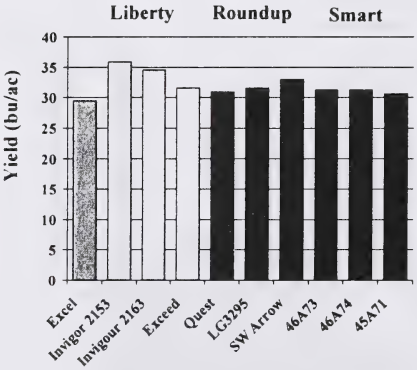
- No reg'd hybrids for RR and Smart
- Average production at $8/bu
- Invigor hybrids at $4.96/lb of seed ($24.80/ac)
- $47.55/ac input



Canola
PRODUCTION CENTRE

Systems Comparison:

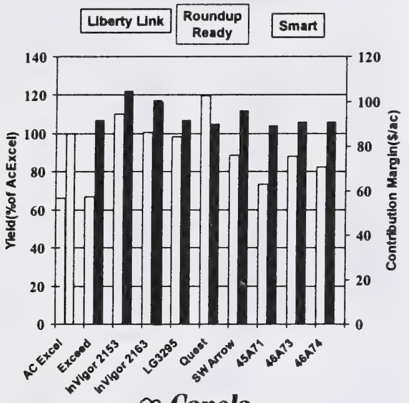
Yield Averages 1998 9 sites



Canola
PRODUCTION CENTRE

Systems Comparison Trial

Yield Averages for 1998 (9 Sites)



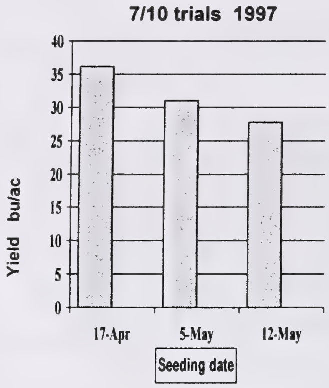
Canola
PRODUCTION CENTRE

Where are they appropriate?

- Roundup Ready: moderate to severe perennial weed problems-thistles, quackgrass and others. Vol. canola.
- Smart: cleavers, light infestations of grassy weeds, expected flushes of annual broadleaf weeds, and volunteer canola
- Liberty: for compromised herbicide rotations (excess use of group 2). Control of volunteer canola. Hybrids for yield. Possible drought resist?
- Fall and Early Seeding: All

Date of Seeding:

Lethbridge (dry)

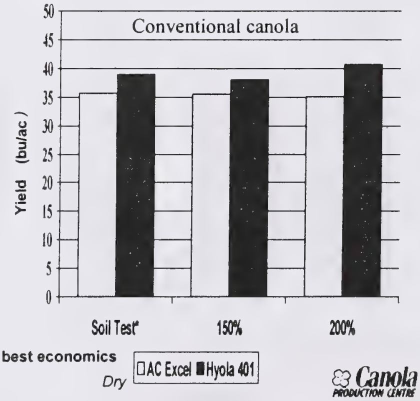


var. Quest

Canola Council of Canada

Variety Response to Fertility:

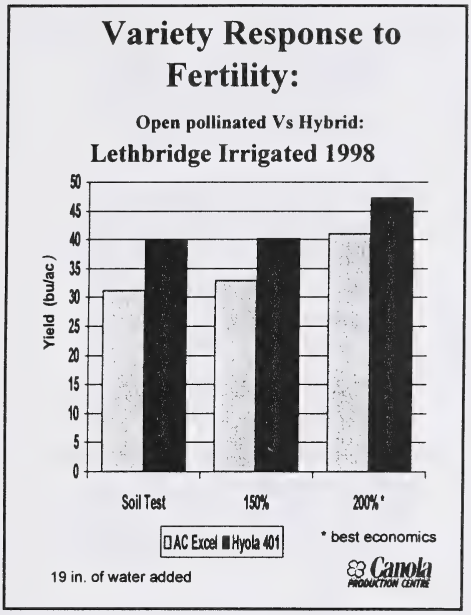
Open pollinated vs Hybrid: Innisfail 1998



* best economics

Dry

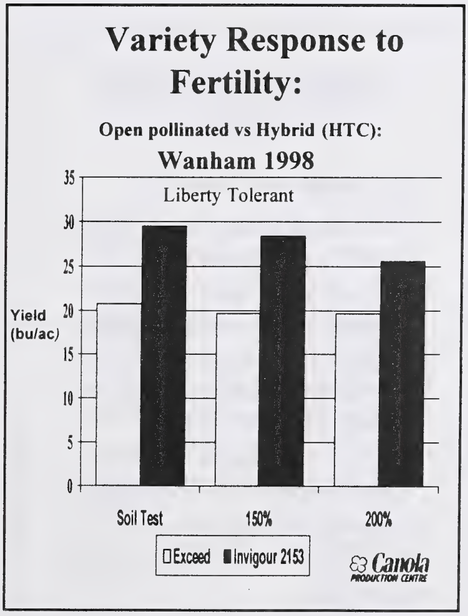
Canola PRODUCTION CENTRE



Variety Response to Fertility:

Open pollinated Vs Hybrid:

Lethbridge Irrigated 1998



Variety Response to Fertility:

Open pollinated vs Hybrid (HTC):

Wanham 1998

Liberty Tolerant

and where are they Inappropriate?

- Yield ? With the exception of the hybrids (Liberty tolerant at this time), the HTC canolas are not particularly high yielding compared with some conventional varieties.
- Early Maturity? Invigor 2153, others not yet.
- Pest resistance? Nothing special over conventional canola choices. There are some new varieties coming with R for Blackleg.

Registered Herbicide Mixes

- Roundup: not an issue
- Liberty: plus Venture 25DG by AgrEvo and Zeneca
- Pursuit: plus Select (RP) by Cyanamid and Rhone-P (field peas)
- Pursuit: plus Poast (BASF) by Cyanamid and BASF.
- Pursuit: plus Venture 25DG by Zeneca, but not by Cyanamid.
- Odyssey: None (Lontrel in 1999?)
- Be careful!

Developments in Transgenic Canola

AgrEvo/PGS (Liberty Link) all hybrids

- 2163 to be discontinued
- 2153 (Cargill) continued support, has been a good performer in 1998. Early maturity.
- 2273 (Agricore) available in 1999, 2 days later than 2153
- 9 new hybrids up for registration, not all of which will be marketed. Improvements in yield, oil, and protein.

Developments in Transgenic Canola

Proven Seeds/Pioneer/UGG

- RR rapa (IP): 41P50, 41P51. MR for blackleg?, white rust=8, (Tobin =50)
- Early napus: 2nd yr. CO-OP A Roundup Ready that's 4 days earlier than checks. Yield is 130% of rapa and 106% of napus.
- 46A73 and 46A74 available in 1999
- Blackleg R rapa in 2nd yr. CO-OP

Other Developments in Transgenic canola

- Pest resistance: Nearly all the companies are working on putting the BT gene complex in canola. Looking for resistance to root maggots, lygus, diamond back, bertha, and cabbage seed pod weevil. Some time yet before we see this in the field. Each pest requires a separate BT gene transfer.

Canola Council of Canada

Other Issues in Transgenic canola

- Outcrossing: occurs in all canola crops. B. napus outcrosses about 12% in the field, and about 3% (or less) between fields.
- Volunteers under direct seeding- add a phenoxy to the Roundup burnoff.
- Keep good records of crop and herbicide use.

Canola Council of Canada

Terminator Technology

- The concept has been around for a long time
- USDA and Delta PineLand Cotton have developed and patented one type of terminator gene for cotton.
- Monsanto is negotiating the purchase of Delta Pine Land.
- So what does this mean to canola growers?

What does Terminator Tech. do?

- The resulting seed will not germinate (initiator turned off)
- Can be one gene (in one parent) or parts of a gene in both parents. (out-crossing issue)
- This separates the grain (to be crushed) from the seed (to produce more) in the industry
- It also controls volunteers very nicely.

What does Terminator tech. mean?

- It protects the breeders rights
- Basically the same idea as hybrids and transgenics, in that :
- you continue to grow a variety for its benefits to you as a producer (Yield, Oil content-if premiums, disease resistance, weed control issues, insect resistance, and volunteer control) but not as a source of seed.
- We will not lose our open-pollinated varieties.

Perspective

- The choice of variety (characteristics) is greater now than 10 years ago.
- We have more options for weed control.
- We will have more options for pest (insects and diseases) control.
- More options means more careful selection.
- Stay on top of developments and choose wisely.

Canola Council of Canada

Successful Crop Rotations

Gary Martens, Instructor
University of Manitoba, Winnipeg

History

The Romans recognized benefits of crop rotation very early in their practice of agriculture. They observed that crops yielded more when grown after another crop type then when grown after the same crop. We still observe this phenomenon today. The Manitoba Crop Insurance Corporation has records, which show us that wheat yields more when grown after other crops than when grown after wheat.

Farmers have developed crop rotations over thousands of years for specific regions that work. By trial and error, farmers have discovered which crops work best in an area and what sequence to plant them in. Agriculture Canada Research Stations and Universities have conducted long-term rotation studies on the prairies since the inception of these institutions. S. Brandt has written a detailed summary of all the crop rotation research studies that have been carried out on the prairies over many years [Brandt S. Proceedings of the Crop Rotations Conference, Saskatoon, 1994]. Hopefully the research speeds up the process of determining which crops to grow and in what sequence.

Benefits of Crop Rotation

In general all crops do better when rotated as seen by the chart from Manitoba Crop Insurance Corporation [Figure 1] showing the increase in wheat yields following crops other than wheat. Crop rotations also spread the high risk of farming over more crops, providing more economic stability than monoculture, which may have its very good and very bad years depending on the luck of choosing the right crop for a given year [Button R. Economic Aspects of Crop Rotations, Proceedings of the Crop Rotation Conference, Saskatoon, 1994] [Halvorson A D, Black A L. Dryland Cropping Systems and Economics, Advancing the Art, Minot, 1996].

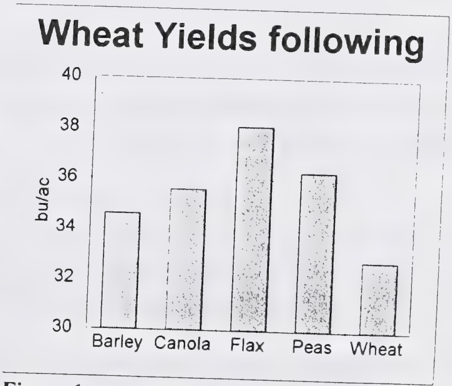


Figure 1 source: Manitoba Crop Insurance

Equipment and labor use can be distributed over time with good planning. This allows for smaller equipment to cover the same number of acres per year and fewer people to do the work necessary.

Rotating crops helps to reduce pest problems. A reduction in crop diseases, insects, and weeds are a benefit of crop rotations. Recently the problem of herbicide resistance has again reared its ugly head. The October 15, 1998 edition of the Western Producer featured a front page story about a Roundup Ready canola crossing with a conventional canola to produce a surprise volunteer canola that was not controlled by a spring burn-off with Roundup. The problem of these volunteers is that they do not look any different than conventional volunteers. This type of problem is serious for direct seeders who rely on Roundup for a spring burn-off to get a clean start to their new crops.

Our farming systems have been quite simple in the past, mostly spring annual crops planted at the same time each year. Weeds can adapt very nicely to this predictable system [Figure 2]. A biological system is very complex. Direct seeding if practiced with extended and complex rotations including variations in seeding dates will help reduce weed pressure and delay or avoid herbicide resistance from developing [Figure 3].

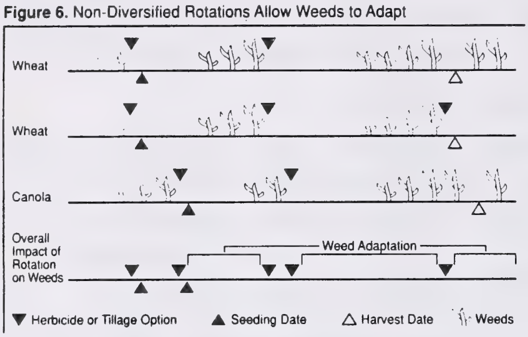


Figure 6. Non-Diversified Rotations Allow Weeds to Adapt
Wheat
Wheat
Canola
Overall Impact of Rotation on Weeds
Weed Adaptation
▼ Herbicide or Tillage Option
▲ Seeding Date
△ Harvest Date
Weeds

Figure 2 from Principles and Practices of Crop Rotation, Saskatchewan Agriculture and Food

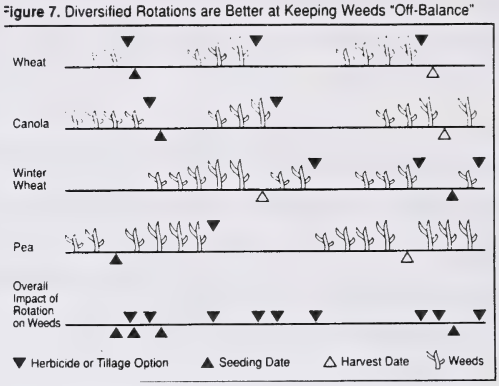


Figure 7. Diversified Rotations are Better at Keeping Weeds "Off-Balance"
Wheat
Canola
Winter Wheat
Pea
Overall Impact of Rotation on Weeds
▼ Herbicide or Tillage Option
▲ Seeding Date
△ Harvest Date
Weeds

Figure 3 from Principles and Practices of Crop Rotation, Saskatchewan Agriculture and Food

Using a proper crop rotation can help balance nutrient use. When properly alternated, different nutrients are consumed in more sustainable proportions. When legumes are included nitrogen is maintained. A well planned crop rotation provides for livestock needs, if livestock are a part of the farm operation. Appropriate longer term moisture usage can also be planned for by a good manager through skilled planning of crop rotations.

Factors Influencing Crop Rotation Decisions

Many factors influence crop rotation decisions made by direct seeders. These factors can be divided into three broad categories. Physical considerations like the soil characteristics, the climate and the moisture available, prevalent pests and equipment and time available would all influence a grower's crop rotation.

The second factor would be economic considerations like the cost of inputs or credit, the marketing opportunities available and the impact of agricultural policies. Included in this second factor one could probably include the level of risk a grower is willing to take or has the ability to take. [See crop rotations and budgets at www.agr.gov.sk.ca/saf/farmfact/fmb0197a.htm]

The management capabilities of a grower could be considered the third major factor influencing crop rotation decisions. The level of knowledge of a grower or the inability to obtain information might limit the diversity of a crop rotation.

Current Crop Rotation Practices in Alberta

From 1996 Census data we can determine approximately what farmers where growing in 1996. The data allows us to look at how direct seeding and reduced tillage are being adopted. The province of Alberta has been divided in 19 Census Districts [See attached map and map description]. The average acceptance of direct seeding for the province is about 9% and varies from 2-19%. Reduced and conventional tillage still accounts for 81-98% of the acres by Census District. [See Table 4]

Typical crop rotations can be extracted from the Census data using the "in crop", "alfalfa", "hay", and "fallow" acres. Assumptions need to be made about the actual sequencing of the crops, but the percentage in each crop can be calculated [See Table 3].

Since the amount of reduced and conventional tillage is still the majority of the acres, we can assume that the "typical" crop rotations presented in the "typical" rotation will represent conventional and reduced tillage systems.

Comparing Direct Seeding Rotations with "Typical Rotations"

How do direct seeding farmers compare in their crop rotation practices with the "typical" crop rotations? This information was collected in phone interviews with farmers and with some of the ARTI agronomists. Table 1 represents selected Census Districts comparing "typical" rotations with direct seeding rotations that some farmers are using. These rotations have developed slowly over time, some over 20 years, using trial and error and hopefully some research results.

By comparing the "typical" crop rotations with the direct seeding rotations from the same Census District one can see that two common trends emerge. One is an intensification of the rotations, that is, less fallow acres especially in high fallow Census Districts like District 1 and 4. The other common trends is one of more diversification in the direct seeding rotations.

Dr. Dwayne Beck of Dakota Lakes Research Farm says, "The [no-till and reduced tillage] systems have done an excellent job of conserving water and soil. They have been less consistent in translating water savings into the expected yield increases and/or economic returns. One notable reason for this lack of response has been the failure to change crop rotation practices at the same time tillage practices are changed. Rotations used in conservation systems must be more intense and diverse than those used with conventional practices." [Beck D. Advancing the Art, 18th Annual Zero Tillage Workshop, Minot North Dakota, 1996]

It seems that direct seeding farmers are either figuring out, by trial and error and/or by following the research that these two features-intensification and diversification are the keys to successful direct seeding rotations.

The failure of some direct seeding farmers to adopt new crop rotation practices has led in some cases to increased problems with weeds, diseases and soil salinity.

Including Forages in Direct Seeding Crop Rotations

At the University of Manitoba, Dr. Martin Entz and Dr. Ray Smith and at Agriculture Canada - Brandon Dr. Doug Derksen are contributing to the bank of information that might help diversify direct seeding rotations.

The classical view of forage crops is to put them on the marginal land and not include them in the annual cropping rotations. The 1996 Census of Agriculture also has this view. A close look at their definition of "in crop" excludes alfalfa and hay crops. They are classified separately, reflecting this classical view.

Each district and each direct seeding farmer will have to evaluate how forages might fit into their moisture regime. Including short term rotations of forages in annual crop rotations has been found to be beneficial.

Benefits of Including Forages

Better water infiltration is one of the benefits of including perennial forage in rotations [1] [2,3,4,5] because of the extensive root system developed by perennial alfalfa and hay crops. Instead of having precious water leaving the field during periods of short term excess, it stays and is absorbed into the root zone for increased potential yield.

Effective and inexpensive weed control [8,9,10,11] is another tangible benefit offered by forage crops. A survey conducted in 1992 [Entz M H, Bullied W J, and Katepwa-Mupondwa, 1992] found that 83% of respondents found weed control benefits up to two years following the forage crop.

The two most common reasons for forage stand termination were reduced yield and pocket gophers. Less than 12% of respondents sited crop rotation reasons for terminating a forage stand. Research [Entz M H as above] shows that weed control benefits and nitrogen benefits are realized after only 3 years of a forage stand. [16,17]

Limitations of Including Forages

There are some limitations of including forages in rotations [22,23,24]. One of the most important for many areas of Alberta would be the amount of moisture used by the forage crop in comparison to an annual crop [Figure 2] [Campbell C A, Zentner R P, Janzen H H, Bowren K E, 1990]. Direct seeding systems, though, and a shortened forage stand could allow for the use of forage to diversify direct seeding systems in some Census Districts.

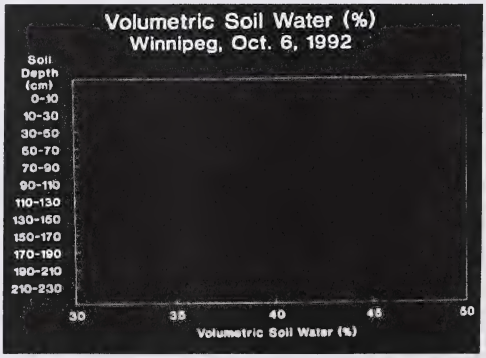


Figure 2 from Dr. Martin Entz, U of Manitoba

Establishing forages in conventional tillage dries out the soil and unless precipitation occurs within several weeks of seeding, forage stand establishment is reduced compared to direct seeding systems [18,19,20,21] where excellent moisture is maintained near the surface of the soil. [Entz M H, 1992] [Figure 3]

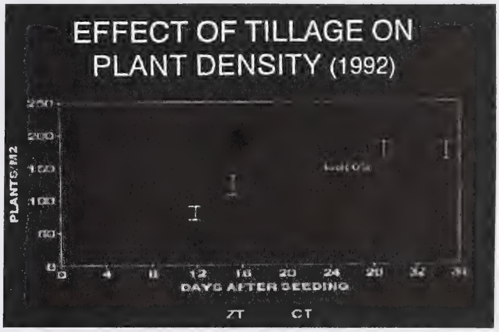


Figure 3 from Dr. Martin Entz, U of Manitoba

Removing Forages in Direct Seeding Systems

Removing perennial forages from the rotation [25,26,27] can be done very successfully in direct seeding systems using Roundup at 1.5 liters per acre (more Roundup with higher amounts of grass in the forage mix) and 0.4 liters of 2-4-D. It is usually better to remove them in the fall rather than in the spring. Annual forages generally do not need chemical removal. Dr. Ray Smith of the University of Manitoba is selecting for non dormant alfalfa that may be useful as an annual forage with termination done by the winter season rather than Roundup. Including perennial forages requires either an on farm market for the production or arrangement of cash sales to local or distant markets.

Annual Forages

Another diversification option is the inclusion of annual forages [12,13,14,15] in the annual crop rotations. Dr. Ray Smith at the University of Manitoba is selecting for alfalfas that have no dormancy. This allows these alfalfas to be used as annual crops with two cuts per year with a respectable tonnage per acre and no requirement to terminate the stand with chemicals or tillage because of the susceptibility of these varieties to winter kill. Winter and spring cereal crops have also been used very successfully as annual forages.

Double Cropping and Relay Cropping Using Forages

A third method of diversification and intensification using forage crops is to use them in double cropping or relay cropping systems. Dr. Martin Entz recently visited Australia, where interest is great in developing this for direct seeding systems. Some varieties of medic, lentils, clovers, and grass pea are being used in research trials at the University of Manitoba. It is too early to present any data, but this summers experience shows promise.

Direct seeding farmers are showing interest in strategies for intensification and diversification because these strategies are essential for the successful practice of direct seeding systems. Each district and each direct seeding farmer will have to design a crop rotation that works for them [See Table 2].

When you turn the volume control on a radio you get instant feedback. When you adjust the water temperature in the shower you need to learn to wait for the temperature to adjust before turning the tap some more, the feedback is slightly delayed. When you make adjustments to your turning the tap some more, the feedback is slightly delayed. When you make adjustments to your crop rotations you will have to wait for years to get the feedback. The feedback is not easy to read because of the complications of weather, economics and other variables. Hopefully you can learn from successful practitioners of direct seeding, from the research community and from your own trials to develop successful direct seeding crop rotations to satisfy your long term requirements.

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Smith R S, University of Manitoba, unpublished research.

Table 1

Census District	"Typical" Rotations	Example Direct Seeding Rotations
1	CE - F - CE - F	CE - C - CE - P
1		CE - CE - C/M - CE - P
4	CE - FO/C/M - CE - F	CE -F - L/P - F - C/M
4		CE - CE - P - CE - C/M
4		WCE - P/C/M - CE - F
10	CE - CE - C - CE - F/P	CE - CE - C - CE - F/P
11	CE - C/F - CE - FO	C - CE - CE - P - C - FO - FO - FO
19	CE - C - CE - P/F	

Source of "typical" rotation: 1996 Census of Agriculture, Agricultural Division, Statistics Canada. Source of direct seeding rotation: Telephone interviews with farmers and correspondence with ARTI agronomists.

Legend for Table 1: CE=cereal, WCE=winter cereal, C=canola, M=mustard, F=fallow, P=peas, L=lentils, FO=forage, FL=flax

Example Direct Seeding Rotations including Legumes and/or Forages

Table 2

Moisture Regime	No livestock/No market/Green manure	Livestock/Available market
Dry	WCE/DCmedic/DClentil-C/M-CE-P	CE-AF-C/M-CE-P
Not Dry	WCE/RClentil/RCclover-CE-P-CE-C/M	C - CE - P - CE - C - FO - FO - FO

Legend for Table 2: WCE=winter cereal, DC=double crop, C=canola, M=mustard, P=peas, RC=relay crop, FO=forage, AF=annual forage

Table 3 Acres

District	Wheat	Oats	Barley	Rye	Canola	Flax	Peas	Lentils	Sum incrop	Alfalfa	Hay	Fallow	Total
1	684305	16178	109920	4077	66268	0	3541	7656	891945	63962	22569	451159.00	1429635
2	876130	21125	428243	4880	163231	6601	11335	6161	1517706	160452	50350	392719.00	2121227
3	346682	29651	475007	2419	103613	1297	0.0	0	958669	141393	47798	82937.00	1230797
4	575324	108328	102258	21046	63951	0	1540	1795	874242	138708	49226	559511.00	1621687
5	1131742	33576	578569	13864	328844	6787	20047	2305	2115734	89546	33867	633962.00	2873109
6	261872	53911	616336	0	0.0	0	9999	0	942118	199603	139921	122729.00	1404371
7	857617	186632	496743	20469	382547	3786	29835	0	1977629	192372	93955	314828.00	2578784
8	133209	45721	589335	1965	107085	0	12848	0	890163	252095	132046	36336.00	1310640
9	1476	13854	36753	180	2013	0	234	0	54510	54896	86841	6475.00	202722
10	946592	231300	748972	7850	547711	5831	75972	392	2564620	211156	106156	273658.00	3155590
11	216552	142627	424851	2386	162934	0	21453	0	970803	332177	218501	71054.00	1592535
12	70585	107501	223303	1284	84614	0	8874	0	496161	279959	96515	73304.00	945939
13	151294	154496	425116	1758	112087	0	16944	0	861695	400114	232199	104891.00	1598899
14	4727	25583	22202	92	3006	0	199	0	55809	21775	73182	11142.00	161908
15	1165	550	2713	0	0.0	0	0.0	0	4428	3146	2998	526.00	11098
17	290296	88129	208456	2323	354204	0	20469	0	963877	186793	142977	175567.00	1469214
18	61221	21395	18766	0	32723	0	3053	0	137158	39840	73310	26492.00	276800
19	714057	105622	268281	0	501389	4977	48955	0	1643281	229666	153101	212975.00	2239023
Totals	7324846	1386179	5775824	84593	3016220	29279	285298	18309	17920548	2997653	1755512	3550265	
1	48%	1%	8%	0%	5%	0%	0%	1%	62%	4%	2%	32%	
2	41%	1%	20%	0%	8%	0%	1%	0%	72%	8%	2%	19%	
3	28%	2%	39%	0%	8%	0%	0%	0%	78%	11%	4%	7%	
4	35%	7%	6%	1%	4%	0%	0%	0%	54%	9%	3%	35%	
5	39%	1%	20%	0%	11%	0%	1%	0%	74%	3%	1%	22%	
6	19%	4%	44%	0%	0%	0%	1%	0%	67%	14%	10%	9%	
7	33%	7%	19%	1%	15%	0%	1%	0%	77%	7%	4%	12%	
8	10%	3%	45%	0%	8%	0%	1%	0%	68%	19%	10%	3%	
9	1%	7%	18%	0%	1%	0%	0%	0%	27%	27%	43%	3%	
10	30%	7%	24%	0%	17%	0%	2%	0%	81%	7%	3%	9%	
11	14%	9%	27%	0%	10%	0%	1%	0%	61%	21%	14%	4%	
12	7%	11%	24%	0%	9%	0%	1%	0%	52%	30%	10%	8%	
13	9%	10%	27%	0%	7%	0%	1%	0%	54%	25%	15%	7%	
14	3%	16%	14%	0%	2%	0%	0%	0%	34%	13%	45%	7%	
15	10%	5%	24%	0%	0%	0%	0%	0%	40%	28%	27%	5%	
17	20%	6%	14%	0%	24%	0%	1%	0%	66%	13%	10%	12%	
18	22%	8%	7%	0%	12%	0%	1%	0%	50%	14%	26%	10%	
19	32%	5%	12%	0%	22%	0%	2%	0%	73%	10%	7%	10%	

Source: 1996 Census of Agriculture, Agricultural Division, Statistics Canada (calculations done by Gary Martens, University of Manitoba)

Table 4 **Acres**

District	Till 0	Till-	Till+	Total till	Chemfallow	Tillfallow	Combofallow
1	175825	268265	503686	947776	69651	296238	85270
2	152292	531327	972708	1656327	63849	208047	120823
3	96365	468127	434793	999285	11272	40324	31341
4	138951	311679	485986	936616	44857	335242	179412
5	350386	973330	841594	2165310	58774	271164	304024
6	67843	422053	638801	1128697	16529	47683	58517
7	217421	764329	1066907	2048657	32016	139205	143607
8	39897	180865	704374	925136	3094	20496	12746
9	1587	10802	46573	58962	1396	4217	862
10	293678	851199	1486155	2631032	20246	117718	135694
11	72303	239789	690282	1002374	4944	39692	26418
12	60316	125154	328710	514180	7052	38662	27590
13	28000	192461	672677	893138	7908	63300	33683
14	1090	6932	52304	60326	709	7779	2654
15	697	253	3936	4886	0	270	256
17	88011	284411	605487	977909	16673	90368	68526
18	4853	36906	97988	139747	1373	14114	11005
19	146855	499040	1024863	1670758	21052	89684	102239
1	19%	28%	53%		15%	66%	19%
2	9%	32%	59%		16%	53%	31%
3	10%	47%	44%		14%	49%	38%
4	15%	33%	52%		8%	60%	32%
5	16%	45%	39%		9%	43%	48%
6	6%	37%	57%		13%	39%	48%
7	11%	37%	52%		10%	44%	46%
8	4%	20%	76%		9%	56%	35%
9	3%	18%	79%		22%	65%	13%
10	11%	32%	56%		7%	43%	50%
11	7%	24%	69%		7%	56%	37%
12	12%	24%	64%		10%	53%	38%
13	3%	22%	75%		8%	60%	32%
14	2%	11%	87%		6%	70%	24%
15	14%	5%	81%		0%	51%	49%
17	9%	29%	62%		9%	51%	39%
18	3%	26%	70%		5%	53%	42%
19	9%	30%	61%		10%	42%	48%

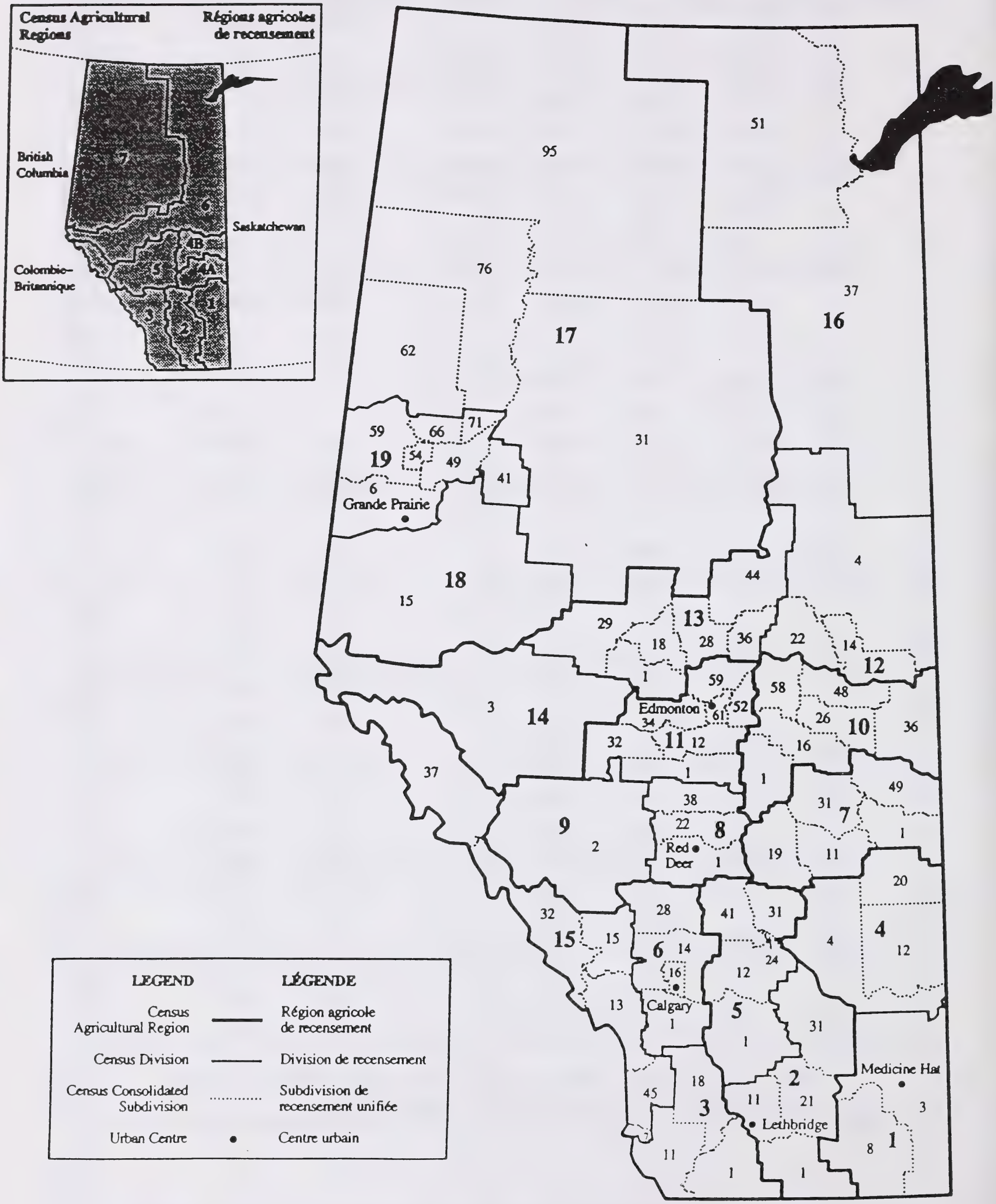
Source: 1996 Census of Agriculture, Agricultural Division, Statistics Canada
(calculations by Gary Martens, University of Manitoba)

ALBERTA

1996 Census Divisions and Census Consolidated Subdivisions

ALBERTA

Divisions de recensement et subdivisions de recensement unifiées, 1996



Source: 1996 Census of Agriculture, Agriculture Division, Statistics Canada

Source: Recensement de l'agriculture de 1996, Division de l'agriculture, Statistique Canada

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Map 2 / Carte 2

1996 Census Divisions and Census Consolidated Subdivisions
Divisions de recensement et subdivisions de recensement unifiées, 1996

1		**Division No. 1**
	3	Cypress No. 1
	8	Forty Mile County No. 8
2		**Division No. 2**
	1	Warner County No. 5
	11	Lethbridge County No. 26
	21	Taber No. 14
	31	Newell County No. 4
3		**Division No. 3**
	1	Cardston No. 6
	11	Pincher Creek No. 9
	18	Willow Creek No. 26
4		**Division No. 4**
	4	Special Area No. 2
	12	Special Area No. 3
	20	Special Area No. 4
5		**Division No. 5***
	1	Vulcan County No. 2
	12	Wheatland County No. 16
	24	Badlands No. 7
	31	Starland No. 47
	41	Kneehill No. 48
6		**Division No. 6**
	1	Foothills No. 31
	14	Rocky View No. 44
	16	Calgary
	28	Mountain View County No. 17
7		**Division No. 7**
	1	Provost No. 52
	11	Paintearth County No. 18
	19	Stettler County No. 6
	31	Flagstaff County No. 29
	49	Wainwright No. 61
8		**Division No. 8**
	1	Red Deer County No. 23
	22	Lacombe County
	38	Ponoka County No. 3
9		**Division No. 9**
	2	Clearwater No. 99
10		**Division No. 10**
	1	Camrose County No. 22
	16	Beaver County No. 9
	26	Minburn County No. 27
	36	Vermilion River County No. 24
	48	Two Hills County No. 21
	58	Lamont County No. 30
11		**Division No. 11**
	1	Wetaskiwin County No. 10
	12	Leduc County No. 25
	32	Brazeau No. 77
	34	Parkland County
	52	Strathcona County
	59	Sturgeon No. 90
	61	Edmonton
12		**Division No. 12***
	4	Bonnyville No. 87
	14	St. Paul County No. 19
	22	Smoky Lake County No. 13
13		**Division No. 13**
	1	Lac Ste. Anne County
	18	Barrhead County No. 11
	28	Westlock No. 92
	29	Woodlands No. 15
	36	Thorhild County No. 7
	44	Athabasca County No. 12
14		**Division No. 14**
	3	Yellowhead No. 94
15		**Division No. 15***
	7	Crowsnest Pass
	13	Improvement District No. 5
	15	Bighorn No. 8
	32	Improvement District No. 9
	37	Improvement District No. 12
	45	Ranchland No. 66
16		**Division No. 16***
	37	Wood Buffalo
	51	*Improvement District No. 24*
17		**Division No. 17**
	31	Opportunity No. 17
	62	Clear Hills No. 21
	76	Northern Lights No. 22
	95	Mackenzie No. 23
18		**Division No. 18**
	15	Greenview No. 16
19		**Division No. 19**
	6	Grande Prairie County No. 1
	41	Smoky River No. 130
	49	Birch Hills No. 19
	54	Spirit River No. 133
	59	Saddle Hills No. 20
	66	Fairview No. 136
	71	Peace No. 135

* Due to confidentiality constraints, the data for some or all of the geographic areas in this Census Division have been amalgamated. See geographic area amalgamations in the Notes to Data Users section for details.
Census Consolidated Subdivisions in italics had no farms in 1996.

* En raison des contraintes qu'impose le respect de la confidentialité, les données relatives à certaines ou toutes les unités géographiques pour cette division de recensement ont été combinées. Pour des détails, voir les unités géographiques combinées dans la section «Notes à l'intention des utilisateurs de données».
Les subdivisions de recensement unifiées qui n'avaient pas de fermes en 1996 sont indiquées en italiques.

Influence of alfalfa on a number of different agronomic and environmental parameters.

Parameter	Nature of Alfalfa Influence	References
Soil Nitrogen	Five year alfalfa stand provides significant N for two following crops. N benefit can last up to 7 years. Release of N from legume residue slower when legume stand terminated using no-till. Annual alfalfa crops can contribute an average of 50 kg/ha N to the soil. As high as 120 kg/ha.	Ferguson and Gorby (1971), Bowren and Cooke (1975), Bailey (1987), Hoyt and Leitch (1983), Mohr, Entz and Janzen (unpub), Bruuslema and Christie (1987), Kelner (1994)
Soil Structure	Alfalfa roots perform "biological tillage", thereby improving soil environment for root growth of subsequent crops. On heavy clay soils, inclusion of alfalfa in rotation increases soil water infiltration. No-till alfalfa removal keeps pores intact.	Blackwell et al. (1990), Entz (1994), Meek et al. (1990), Cavers and Eilers (1994)
Subsoil Nitrogen	A four year alfalfa stand effectively extracted nitrogen to a depth of 260 cm on an Osborne clay in Manitoba. Fallowing the year after forage breaking increases subsoil nitrogen, thereby increasing the risk of ground water contamination.	Entz and Vessey (unpublished) Campbell et al. (1994)
Weeds	Two or three years of forage in a six year rotation virtually eliminated wild oats in cereal crops. A survey of commercial fields in Manitoba indicated significantly fewer wild oats, green foxtail and Canada thistle plants in wheat following forage crops vs. wheat following annual crops. Eighty percent of producers in Mb/Sk survey indicated fewer weeds in annual crops after forage breaking compared with annual crops in an annual crop rotation. Good control of wild oats, green foxtail and Canada thistle was observed for a period of one (11% of respondents), two (50% of respondents), or more (33% of respondents) years.	Siemens (1963) Ominski et al (1994) Entz et al. (1995)
Soil water status after alfalfa	Black and Gray soil zones: Soil water in 0 to 60 cm usually recharged in alfalfa rotation, but subsoil drier. Fallow not required for water recharge after forage breaking. Removing alfalfa stands using no-till increases water recharge by up to 3 cm. Dark Brown soil zone: Including alfalfa in rotation results in moisture shortages in following year. Fallow required for water recharge after forage breaking.	Hoyt and Leitch (1983), Entz (1994), Bullied and Entz (unpublished) Brandt and Keys (1982)
Grain yield in following crops	Recent survey indicated that 71% of producers in Manitoba and Saskatchewan observe a yield benefit from including forages in their crop rotation. Yield benefits greatest in wetter areas and lowest in Brown soil zone. Yield benefits decrease sharply as alfalfa stand length increases beyond four years. Cumulative yield benefit occurs when legumes repeatedly included in cereal based crop rotations. In dry years, grain yields greater when alfalfa removed using no-till vs. tilled system.	Entz et al. (1995) Poyser et al. (1957) Entz and Gulden (unpublished)